HAM TIPS from RCA

VOL. 1—NO. 1 CAMDEN, N. J. SEPT., 1938

PAIR RCA 809's PUTS OVER 100 WATTS IN ANTENNA

RCA 1852 AND 1853 HAVE HIGH GAIN UP TO 60 MEGACYCLES

Ideal for Experimental Amateur and Television Receivers

RCA 1852 and 1853

Announcement of two high gain experimental type receiving tubes by RCA has made it possible for the amateur to obtain good efficiencies at ultra high frequencies, either for experimental or television receivers. The RCA 1852 has the extremely high grid-plate transconductance of 9000 micromhos, while the 1853 has a grid-plate transconductance of 5000 micromhos. The 1853, because of its extended cut-off characteristic, is especially suitable for use in r-f or i-f stages of receivers employing automatic gain control.

The electrode assembly of the 1852 and 1853 has a special shielded lead construction to permit bringing out the control-grid lead to a base pin rather than to a pin cap. With this construction, it has been possible to

(*Continued on page 2, col. 4*)

RCA 814 GIVES GOOD OUTPUT WITH LOW DRIVING POWER

130 Watts Realized for Class "C" Telegraphic Conditions

RCA 814

For the amateur radio transmitter owner who desires the utmost in efficiency for medium powered rigs, the RCA 814 will be found to be the logical answer. Utilizing the principle of directed electron beams and featuring low power absorption by the screen, efficient suppressor action is supplied by space charge effects produced between the screen and plate. The resultant high power sensitivity makes this tube especially suited for use as an r-f amplifier, oscillator and frequency multiplier. In class "C" service, it is capable of giving a power output of 130 watts or better, with a driving power of 1.5 watts. The net price is $17.50.

Rating—Class "C" Telegraphy

DC Plate Voltage	1250
DC Screen No. 2 Voltage	300
DC Screen No. 1 Voltage	300
DC Plate Current	150 M. A.
Plate Input	180 Watts Max.
Plate Dissipation	50 Watts Max.

EXCELLENT ECONOMY OBTAINED THROUGH LOW DRIVING POWER AND TUBE COST

Have 76 Watt Output When Used in Plate-Modulated Telephony Circuit

TT-3 Manual

A book that should be in the library of every radio amateur is the new RCA TT-3 Transmitting Tube Handbook. This 192-page manual gives the complete operating data of all RCA Tubes of the air-cooled type which are used for transmitting purposes. Also included are sections on installation requirements, ratings, transmitter design considerations, and many other useful subjects. All RCA Transmitting-Tube Distributors have this book in stock. Be sure and ask for your copy, the largest 25 cents worth you can buy.

RCA 809

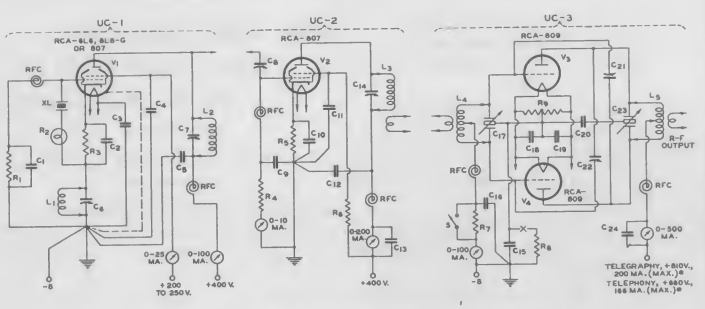
The RCA 809, recently announced to amateurs, is rapidly finding favor because of its outstanding performance and economical net price of $2.50.

The diagram at the lower left shows a simple, 3-stage transmitter that is capable of operating on any of the amateur bands down to and including 10 meters, by means of 4 or 5 plug-in coils. It is an excellent tube arrangement for the beginner, who can later use stage UC-3 to drive another, more powerful stage. The push-pull 809's are capable of driving push-pull, plate-modulated 806's operating at an input of one kilowatt.

A single 809 makes an excellent final amplifier for a low-power transmitter, as well as a buffer or doubler to drive a larger tube. As an amplifier, the 809 will drive a single, plate-modulated 806, or a push-pull stage using 203-A's, 805's, 838's, or 211's. As a doubler, it will drive a single-ended stage using the 203-A, 211, 805, 808, or 838.

Legend

C_1 = 0.001 μf, MICA
C_2, C_3, C_4, C_5 = 0.01 μf, MICA
C_6 = 100 μμf MIDGET
C_7 = 1.0 μμf/METER‡
C_8 = 25 μμf MIDGET
C_9, C_{12}, C_{13}, C_{24} = 0.002 μf, MICA
C_{10}, C_{11} = 0.01 μf, MICA
C_{14} = 1.5 μμf/METER‡
C_{15} = 0.002 μf, 1000 V. MICA
C_{16}, C_{18}, C_{19} = 0.01 μf, MICA
C_{17} = 1.0 μμf/METER/SECTION‡
C_{20} = 0.002 μf, 2000 V. MICA
C_{21}, C_{22} = 6.7 μμf (APPROX.), 4000 V.
C_{23} = 1.5 μμf/METER/SECTION‡
R_1 = 75000 OHMS, 1 WATT
R_2 = 2.0-VOLT, 60-MA. PILOT LAMP
R_3 = 400 OHMS, 5 WATTS
R_4 = 10000 OHMS, 1 WATT
R_5 = 250 OHMS, 5 WATTS
R_6 = 15000 OHMS, 2 WATTS
R_7 = 1600 OHMS, 20 WATTS##
R_8 = 250 OHMS, 20 WATTS
R_9 = 40 OHMS, C.T., WIRE-WOUND
XL = CRYSTAL OF FREQUENCY "f"
L_1 = SEE NOTE**
L_2 = TUNE FOR f, 2f, or 4f (807)†
TUNE FOR 2f or 4f (6L6, 6L6-G)†
L_3 = TUNE TO SAME FREQUENCY AS L_2C_7, OR DOUBLE THAT FREQUENCY
L_4, L_5 = TUNE TO FREQUENCY OF L_3C_{14}
RFC = R-F CHOKE
S = S.P.S.T. SWITCH##
X = INSERT KEYING RELAY HERE
V_1 = TRITET CRYSTAL OSCILLATOR AND HARMONIC GENERATOR**
V_2 = R-F AMPLIFIER OR DOUBLER
V_3, V_4 = R-F POWER AMPLIFIER



PUSH-PULL 809 HIGH-FREQUENCY TRANSMITTER
Class "C" Plate-Modulated Telephony Power Output 76 Watts*
Class "C" Telegraphy Power Output 110 Watts*

* Approximate.

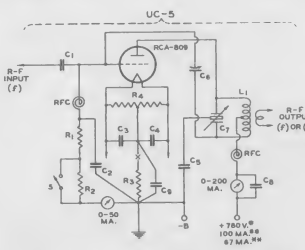
\# This high plate-supply voltage should not be used except with cathode bias, as shown. Without cathode bias, the supply voltage should be reduced to 750 volts, for telegraphy, and to 600 volts, for telephony.

\#\# Close switch "S" for telegraph service; open "S" and increase r-f grid excitation to 64 ma. for plate modulated telephone service.

** See QST for April 1937, for data on Tritet oscillator design, as described by J. J. Lamb. With an 80-meter crystal, L_2C_7 may be tuned to 20 meters and L_3C_{14} to 10 meters.

† L_2C_7 may be tuned to the crystal frequency for "straight through" operation if an 807 oscillator is used. The 6L6 and 6L6-G should be tuned to the second or higher harmonic of the crystal.

‡ Capacitance in actual use.



SINGLE-TUBE R-F AMPLIFIER OR FREQUENCY DOUBLER
Amplifier Power Output 55 Watts*
Doubler Power Output 25 Watts*
UC-5

C_1 = 0.0005 μf, MICA
C_2, C_3, C_4, C_8 = 0.002 μf, MICA
C_5, C_9 = 0.002 μf, 1000 VOLTS, MICA
C_6 = 6.7 μμf (APPROX.), 2000 VOLTS†

(*Continued on page 2, col. 3*)

HAM TIPS FROM RCA

ELECTRIC CHARACTERISTICS OF THE RCA 809

RCA 809 is a three-electrode, high-mu, transmitting tube of the thoriated-tungsten filament type for use as a radio-frequency amplifier, oscillator, frequency multiplier, or class B modulator. Because of its high perveance, the 809 can be operated at high plate efficiency with low driving power. The plate connection is brought out through a separate seal at the top of the bulb to provide good insulation. The internal structure of the 809 permits operation at maximum ratings at frequencies as high as 60 megacycles. The maximum plate dissipation rating is 25 watts for class C telegraph and class B services. The 809 has a ceramic base.

CHARACTERISTICS AND RATINGS

Filament Volts (AC or DC)	6.3	Grid-Plate Capacitance	6.7 μμf
Filament Amperes	2.5	Grid-Filament Capacitance	5.7 μμf
Amplification Factor	50	Plate-Filament Capacitance	0.9 μμf

MAXIMUM RATING AND TYPICAL OPERATING CONDITIONS

As Plate-Modulated R-F Power Amplifier—Class "C" Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

DC Plate Voltage		600 *max.*	Volts
DC Grid Voltage		-200 *max.*	Volts
DC Plate Current		83 *max.*	Milliamperes
DC Grid Current		35 *max.*	Milliamperes
Plate Input		50 *max.*	Watts
Plate Dissipation		17.5 *max.*	Watts
TYPICAL OPERATION:			
DC Plate Voltage	500	600	Volts
DC Grid Voltage	-160	-160	Volts
Peak R-F Grid Voltage	250	250	Volts
DC Plate Current	83	83	Milliamperes
DC Grid Current (Approx.)	32	32	Milliamperes
Grid Resistor	5000	5000	Ohms
Driving Power (Approx.)	7.2	7.2	Watts
Power Output (Approx.)	30	38	Watts

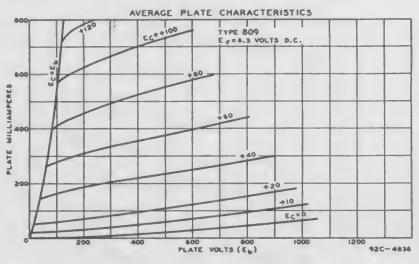
Grid voltages are given with respect to the mid-point of filament operated on AC. If DC is used, each stated value of grid voltage should be decreased by 4.5 volts and the circuit returns made to the negative end of the filament.

As R-F Power Amplifier and Oscillator—Class "C" Telegraphy

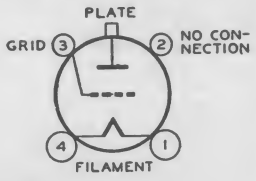
Key-down conditions per special tube without modulation††

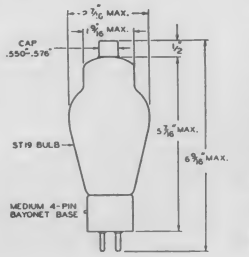
DC Plate Voltage		750 *max.*	Volts
DC Grid Voltage		-200 *max.*	Volts
DC Plate Current		100 *max.*	Milliamperes
DC Grid Current		35 *max.*	Milliamperes
Plate Input		75 *max.*	Watts
Plate Dissipation		25 *max.*	Watts
TYPICAL OPERATION:			
DC Plate Voltage	500	750	Volts
DC Grid Voltage	-50	-60	Volts
Peak R-F Grid Voltage	135	140	Volts
DC Plate Current	100	100	Milliamperes
DC Grid Current (Approx.)	20	20	Milliamperes
Grid Resistor	2500	3000	Ohms
Driving Power (Approx.)	2.5	2.5	Watts
Power Output (Approx.)	35	55	Watts

††Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.



Top View of Socket Connections





INSTALLATION AND APPLICATION

The base pins of the RCA-809 fit the standard 4-contact socket, such as the RCA type UR-542A. The socket should be installed so that the tube will operate in a vertical position with the base down. If it is necessary to place the tube in a horizontal position, the socket should be mounted with the filament-pin openings one vertically above the other so that the plate will be in a vertical plane (on edge).

Pair RCA 809's Puts Over 100 Watts in Antenna

(Continued from page 1, col. 4)

C_7 = 0.75 μμf/METER/SECTION‡
R_1 = 1500 OHMS, 2 WATTS
R_2 = 2500 OHMS, 2 WATTS
R_3 = 250 OHMS, 10 WATTS
R_4 = 40 OHMS, C.T., WIRE-WOUND
RFC = R-F CHOKE
L_1 = TUNE TO FREQ. "f" or 2f"
X = INSERT KEYING RELAY HERE
S = S.P.S.T. SWITCH¶

* Approximate.

\# The extra 30 volts is for the cathode bias developed across R_3; reduce to 630 V. for plate-modulated service.

Maximum for unmodulated class C r-f amplifier service; reduce to 83 ma. for plate-modulated service.

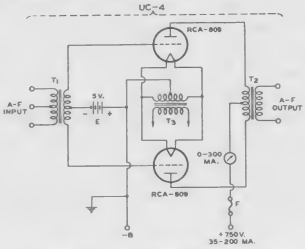
** Maximum for class C r-f doubler service.

† C_6 is not required for frequency doubling.

‡ Capacitance in actual use.

¶ When tube is used as an unmodulated r-f amplifier, close switch "S"; as a frequency doubler and as a plate-modulated r-f amplifier, open "S" and increase r-f excitation to obtain rated d-c grid current.

Two 809's in class B audio service are capable of plate modulating 100% an r-f stage having a d-c plate input up to 200 watts (approx.). Four 809's in push-pull-parallel will deliver 200 watts of audio power and will modulate a transmitter operating with about 400 watts input. Class B 809's are the logical amateur choice for high audio power at low cost.



CLASS "B" MODULATOR OR A-F POWER AMPLIFIER
A-F Power Output 100 Watts*
UC-4

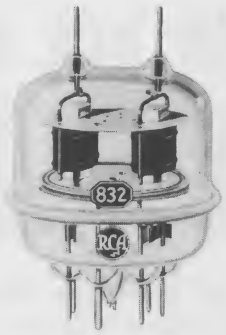
T_1 = INPUT TRANSFORMER
T_2 = OUTPUT TRANSFORMER; PRIMARY IMPEDANCE 8400 OHMS, PLATE-TO PLATE
T_3 = 6.3-VOLT, 5.0-AMPERE, C.T., FILAMENT TRANSFORMER
F = ¼ A. HIGH-VOLTAGE FUSE
* Approximate.

NOTE: When the plate supply is 500 volts, the power output is 60 watts, the plate-to-plate load impedance is 5200 ohms, and "E" should be omitted. Zero-bias operation is recommended only where the plate-supply voltage does not exceed 500 volts. Push-pull 2A3's, self-biased, are suitable for the driver stage.

832 IDEAL FOR LINE-OF-SIGHT TRANSMITTERS

Operate at good efficiency up to 300 megacycles

A new "double" beam power transmitting tube, designed for ultra-high frequency work is now available to experimenters through RCA Tube Distributors. This new tube contains two



RCA-832

beam power units in one envelope. It is designed primarily for use as a push-pull u-h-f power amplifier with maximum ratings at wave-lengths as short as two meters. With reduced ratings it may be operated at wave-lengths down to one meter.

The excellent performance of the RCA 832 results from its compact, balanced structure and close electrode spacing. Its internal shielding eliminates the need for neutralization in properly designed circuits. Short internal leads minimize internal lead inductance. The terminal arrangement provides excellent insulation and facilitates symmetry of circuit layout.

For use in Class C telegraph service, the RCA 832 has a maximum d-c plate-voltage rating of 400 volts, a maximum total plate input of 36 watts, and a maximum total plate dissipation of 15 watts. The heaters are arranged for operation from either a 6.3- or 12.6-volt supply. The amateur net price is $28.75.

RCA 1852 and 1853 Have High Gain Up To 60 Megacycles

(Continued from page 1, col. 1)

keep the grid-plate capacitance as low as that of a similar tube with capped construction. From a circuit standpoint, the proximity of grid pin to cathode pin simplifies wiring and decreases the size of the inductance loop connecting the input circuit to the tube. These are features important at high frequencies because they provide decreased feedback and improved circuit stability.

Both of these tubes use the small 8-pin octal base and have 6.3-volt, 0.45-ampere heater ratings. The amateur net price is only $1.85 for either tube.

HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 1—No. 2 CAMDEN, N. J. OCTOBER, 1938

RAPID BAND CHANGE SIMPLIFIED WITH NEW RCA-814

NEW RCA-813 BEAM POWER TUBE EXCELLENT FOR HIGH POWER RIGS

Delivers 260-Watts Output With Less Than 1-Watt Driving Power

RCA-813

Announcement of a new and powerful beam power output tube—known as the RCA-813—has just been made by all RCA Power Tube Distributors. This new tube, the largest in the RCA beam power amplifier group, requires no neutralization and makes an excellent final amplifier for a quick-band-change, high-

(*Continued on page 2, column 1*)

New Method Used For Presenting Circuits

Helps the Amateur to Choose Proper Tube Line-ups

In HAM TIPS for September, 1938, a number of "unit circuits" on the RCA 809 are shown. In this issue other circuits are shown for the RCA-814. Each individual stage, even in the complete transmitter circuit, has been assigned a "UC" number. Each stage is, insofar as practical, designed as an integral unit, more or less independent of the other units.

As more circuits are published in subsequent issues of HAM TIPS, involving different tube types, the perennial question of selecting a tube line-up will be reduced substantially

(*Continued on page 2, column 1*)

LOW DRIVING POWER REDUCES NUMBER OF TUBES REQUIRED IN EXCITER UNIT

Two-Tube Exciter Provides 10-Meter Operation With 80-Meter Crystal

RCA-814

The new RCA-814 Beam Power Tetrode is the answer for a band-switching transmitter having real power-output capabilities—130-watts output in class C telegraphy and nearly 90 watts in class C plate-modulated telephony service. Band-switching problems are encountered mainly in the exciter unit, therefore simplifying the exciter is the first step in their successful solution. Because the 814 requires negligible driving power, it can be driven directly from the crystal oscillator stage on 160, 80 and 40 meters, using crystals operating on the fundamental frequency desired. For 10- and 20-meter operation, a two-tube exciter is adequate, even with an 80-meter crystal.

Uses Tritet Oscillator

A diagram of a three-tube, 10-meter rig is shown in unit circuits 7 and 8. The exciter unit consists of a combination Tritet crystal oscillator and Reinartz' Harmonic Generator. The 10-meter plate tank of the 809 multiplier is magnetically coupled back to the 20-meter plate tank of the 807 crystal oscillator. When inductances L_2 and L_3 are correctly polarized, a considerable gain in the 10-meter output of the 809 is obtained. Reversing the connections to one of the plate coils (but not both) will provide correct operation, if the connections are incorrect initially.

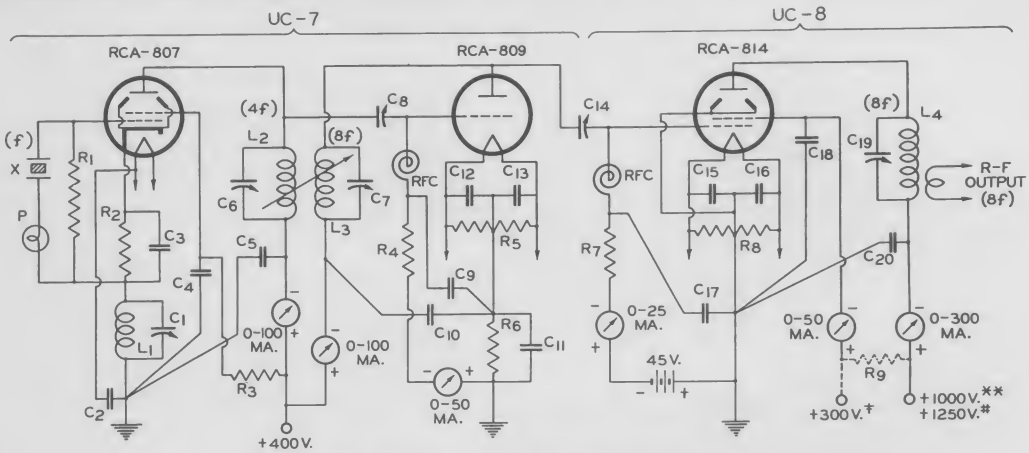
The ease with which band-changing can be accomplished is apparent from the circuit. The cathode coil of the 807 (L_1) does not have to be changed so long as 80-meter crystals are used. With a little experimenting to obtain the proper degree of coupling, coils L_2 and L_3 can be wound on

(*Continued on page 2, column 3*)

WIN $5.00!

Is your transmitter 100% RCA Tubed?

If so, send us a photograph and a short description of it. Each month, one or more 100% RCA Tubed Transmitter Photos will be published in HAM TIPS. Those published win $5.00 cash!



30-MEGACYCLE TRANSMITTER

Class C Plate-Modulated Telephony Power Output 87 Watts*

Class C Telegraphy Power Output 130 Watts*

C_1 = 75 $\mu\mu$f, MIDGET
C_2 TO C_5 = 0.005 μf, MICA
C_6 = 25 $\mu\mu$f, MIDGET†
C_7 = 15 $\mu\mu$f, MIDGET†
C_8 = 50 $\mu\mu$f, MIDGET
C_9 TO C_{13} = 0.005 μf, MICA
C_{14} = 35 $\mu\mu$f, MIDGET
C_{15} TO C_{17} = 0.002 μf, MICA
C_{18} = 0.001 μf, MICA, 2000 VOLTS**
C_{18} = 0.01 μf, MICA, 500 VOLTS#
C_{19} = 15 $\mu\mu$f, 3000 VOLTS†
C_{20} = 0.002 μf, 3000 VOLTS
R_1 = 0.1 MEGOHM, 0.5 WATT
R_2 = 500 OHMS, 2 WATTS
R_3 = 30,000 OHMS, 2 WATTS (NOTE 2)
R_4 = 2000 OHMS, 2 WATTS
R_5 = 40 OHMS, C.T., WIRE-WOUND
R_6 = 200 OHMS, 5 WATTS
R_7 = 10,000 OHMS, 2 WATTS**
R_7 = 3500 OHMS, 1 WATT#
R_8 = 50 OHMS, C.T., WIRE-WOUND
R_9 = 40,000 OHMS, 25 WATTS‡
L_1 = 6 μh, FOR CRYSTAL FREQ. = f
L_2 = 4.8 μh, TUNED TO 4f (NOTE 1)
L_3 = 3 μh, TUNED TO 8f (NOTE 1)
L_4 = 1.37 μh, TUNED TO 8f
RFC = R-F CHOKE
P = 2.0-VOLT, 60-MA. PILOT LAMP
X = 80-METER CRYSTAL OF FREQUENCY f

* Approximate.
† See text.
** For plate-modulated telephony.
# For CW telegraphy.
‡ Screen voltage for telegraphy should be obtained from a separate, fixed-voltage source; for telephony, by means of R_9.

NOTE 1: L_2 and L_3 must be properly polarized for correct operation.

NOTE 2: If the 807 is keyed for "break-in" operation, its screen voltage should be obtained from a fixed-voltage source of 200 volts, and not through R_3.

NOTE 3: The "Tritet" type of crystal oscillator circuit was originally described by Mr. J. J. Lamb in "QST."

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HAM TIPS from RCA

New RCA-813 Beam Power Tube Excellent For High Power Rigs

(*Continued from page 1, column 1*)

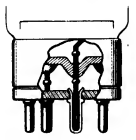
powered amateur transmitter. It has outstanding performance and is characterized by unusually rugged mechanical construction.

The new 813 is among the finest transmitting tubes RCA has ever developed, employs a new stem structure which makes practical a compact tube—only 7½" long—having very short heavy leads and low lead inductance. Because of its design, this new high-power beam tube can be operated at full ratings up to 30 megacycles without neutralization.

Moulded glass stem assembly showing individual lead seals.

Other noteworthy features of this new tube are: Heavy-duty thoriated-tungsten filament, oversized graphite plate, dome-top bulb with cushion mount supports, low screen current, and a new Giant 7-pin base having short shell and wide pin spacings. The amateur net price is $28.50.

Typical Operation
(Class "C" Telegraphy)



View of short, heavy leads to terminal pins.

Filament Voltage.....10 volts (AC or DC)
Filament Current..5 amperes
DC Plate Voltage..2000 volts
DC Screen Voltage..400 volts
DC Grid Voltage...−90 volts
DC Plate Current 180 milliamperes
DC Screen Current 15 milliamperes
Driving Power.....0.5 watt
Power Output.....260 watts

New Method Used For Presenting Circuits

(*Continued from page 1, column 2*)

to the mere selection of a suitable combination of unit circuits. In those border-line cases where the amateur may be in doubt as to whether one UC stage will deliver sufficient power to drive another UC stage, he can readily obtain additional information by writing to RCA Manufacturing Co., Commercial Engineering Section, Harrison, New Jersey.

The circuits, in general, are designed for the maximum power output consistent with reliable performance and true tube economy—which means that all tubes are operated within their maximum ratings. Designed by radio engineers who are also active amateurs, the circuits will be found to give those uniformly fine results of which RCA transmitting tubes are capable.

A complete file of HAM TIPS in every station will be found of considerable value. See your distributor each month to insure that you get each new issue as it appears.

DO YOU KNOW THAT—

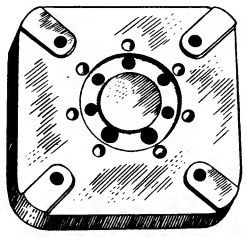
—more than 80 different chemical elements and compounds are used in making RCA tubes, and that

—these materials are bought from every continent on earth—from the Malay States to Africa, from Bolivia to Canada?

LOW-LOSS SOCKET DESIGNED TO FIT NEW RCA-813 TUBE

Has Steatite Base and Positive Spring Contacts

Announcement of a new high-quality low-loss socket, especially designed for the RCA-813 beam power tube, has just been made by the RCA Amateur Equipment Division. This socket, which has such features as two-point



RCA UT-104 SOCKET

wiping contacts, positive spring tension and newly designed mounting bosses, has an attractive amateur net price of $1.25. It is known as Type UT-104 and may be procured through all RCA Amateur Equipment Distributors on or about Nov. 15, 1938

The design of the Model UT-104 socket is such that it insures the highly efficient operation of the RCA-813 tube at its maximum frequency ratings without adding appreciable losses. This is very important when the RCA-813 is used at frequencies of 30 megacycles and above.

Other important features include glazing the top and wax-treating the bottom of the ceramic base to prevent losses due to climatic conditions and a finder ring to facilitate locating the tube pins.

Rapid Band Change Simplified With New RCA-814

(*Continued from page 1, column 4*)

the same plug-in form. Thus, including L_4, only two plug-in coil forms are needed to change bands.

The exciter unit UC-7 is shown for 10-meter operation. For 20 meters, design L_2 for 40 and L_3L_4 for 20 meters. For 40 meters, switch C_{14} from the plate of the 809 to the plate of the 807, disconnect C_8 from the 807 plate, and tune L_2L_4 to 40 meters. For 80 meters, repeat the 40-meter procedure, but tune L_2L_4 to 80 meters and short-circuit L_1. For 160 meters, change the crystal to that band, short-circuit L_1, and tune L_2L_4 to 160 meters; the other connections are the same as for 40 and 80 meters. Whenever L_3 is in use, it will always be tuned to *twice* the frequency of L_2, because the 809 is not intended for use as a straight r-f amplifier in this circuit. Because the various tuned circuits show *actual operating capacitance* values for 10 meters only, the values of C_6, C_7, and C_{19} should be increased for operation on 160, 80, 40, and 20 meters. The increase should be about in direct proportion to the wavelength. Thus, for 20 meters, C_{19} should have an operating value of 30 μμf, instead of 15 μμf as shown in the legend. Multiple-section variable condensers are advisable if three or more bands are to be covered.

The 814 stage (UC-8) can be used to drive a much more powerful r-f amplifier, if desired. Even with another power stage added, only three plug-in forms will be needed.

Diagram UC-6 shows a circuit for two 814's in push-pull, designed for either plate-modulated telephony or for CW telegraphy. A single 809 operated as a frequency doubler will easily drive this push-pull stage. As shown, the 814 circuit can be used for "break-in" telegraph operation, where the oscillator stage is keyed.

Circuit UC-9 shows a grid-modulated 814 stage. Due to the high power sensitivity of this tube, very little a-f modulating power is needed to provide a well-modulated 'phone signal.

VOLTAGE REGULATOR TUBES OPERATE OVER WIDE LOAD CHANGES

New Types RCA-VR105-30 and RCA-VR150-30 Added to Line

The new voltage regulator tubes, designed for a wide variety of applications, have recently been announced to radio amateurs by RCA Power Tube Distributors. Both tubes are identical, except that the VR105-30 is designed for 105-volt circuits while the VR150-30 is designed for 150-volt circuits. Each carries an amateur net price of $1.25.

These tubes are of the cold cathode, glow discharge type, intended for applications where a constant DC output voltage is required for varying values of DC load current. They also may be used as an oscillator in relaxation circuits and for spark-over protection.

Ratings and Characteristics

RCA-VR150-30

Starting Supply Voltage (DC).....180 min. Volts
Operating Voltage (DC).....150 approx. Volts
Operating Current (DC)* { 5 min. Milliamperes / 30 max. Milliamperes

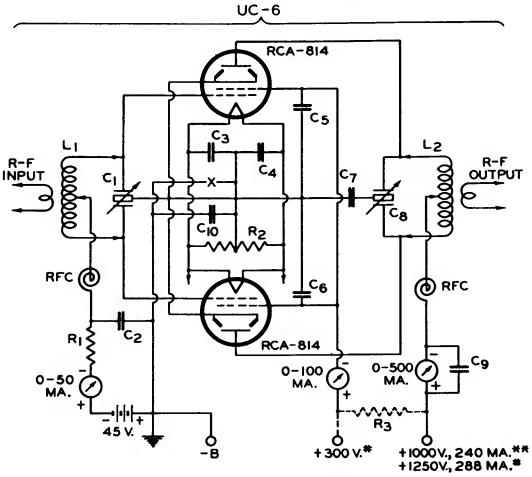
RCA-VR105-30

Starting Supply Voltage (DC).....137 min. Volts
Operating Voltage (DC).....105 approx. Volts
Operating Current (DC)* { 5 min. Milliamperes / 30 max. Milliamperes

* Sufficient resistance must always be used in series with this tube to limit the current through it to 30 ma.

The standard ST-12 small shell octal 6-pin base is used on both tubes. The overall dimensions are 4⅛" high and 1 9/16" maximum diameter.

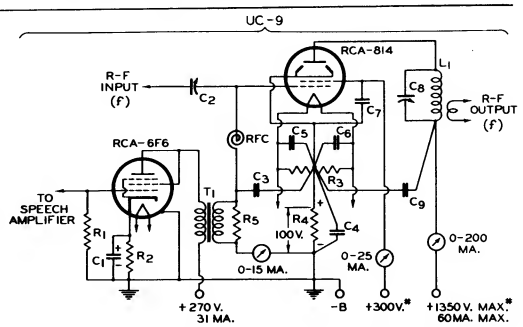
LEFT, PUSH-PULL 814 R-F AMPLIFIER
Class C Plate-Modulated Telephony Power Output 175 Watts*
Class C Telegraphy Power Output 260 Watts*



C_1 = 1.5 μμf/METER/SECTION
C_2, C_3, C_4, C_9 = 0.002 μf, MICA
C_5, C_6, C_{10} = 0.001 μf, MICA, 2000 VOLTS
C_7 = 0.002 μf, MICA, 3000 VOLTS
C_8 = 1.5 μμf/METER/SECTION
R_1 = 5000 OHMS, 5 WATTS**
R_1 = 1750 OHMS, 2 watts#
R_2 = 50 OHMS, C.T., WIRE-WOUND
R_3 = 20,000 OHMS, 50 WATTS **‡
L_1, L_2 = SELECT FOR BAND DESIRED
RFC = R-F CHOKE
X = INSERT KEYING RELAY HERE

* Approximate.
** For plate-modulated telephony.
\# For CW telegraphy.
‡ In telegraph service, omit R_3 and use a separate, fixed-voltage source for the screen voltage.

NOTE: With partial fixed bias, as shown, the oscillator stage may be keyed for "break-in" operation, if desired. When no fixed bias is used, R_1 should be changed to 7500 ohms** or to 4000 ohms#.



GRID-MODULATED R-F AMPLIFIER
Power Output 29 Watts*

C_1 = 25 μf, ELEC., 50 VOLTS
C_2 = 35 μμf, MIDGET
C_3 = 0.002 μf, MICA
C_4, C_5, C_6, C_7 = 0.005 μf, MICA
C_8 = 0.6 μμf/METER
C_9 = 0.002 μf, MICA, 2000 VOLTS
R_1 = 0.5 MEGOHM, 0.5 WATT
R_2 = 645 OHMS, 2 WATTS
R_3 = 50 OHMS, C.T., WIRE-WOUND
R_4 = 1560 OHMS, 20 WATTS
R_5 = 8000 OHMS, 1 WATT
RFC = R-F CHOKE
L_1 = TUNE TO FREQUENCY f
T_1 = MODULATION TRANSFORMER, TURNS RATIO, P/S = 1.3; PRIMARY LOAD IMPEDANCE = 4000 OHMS

* Approximate.
\# The extra 100 volts is to compensate for the voltage drop across cathode resistor R_4; grid, screen, and plate voltages are measured to the filament. The screen voltage should be obtained from a separate, fixed-voltage source, or from a voltage divider having good regulation—not from a series resistor.

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Form No. 3834

HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 1—No. 3 CAMDEN, N. J. NOVEMBER, 1938

PUSH-PULL RCA-810'S DELIVER 750 WATTS TO ANTENNA

50-WATT RIGS ARE EASILY MODERNIZED WITH NEW RCA-810

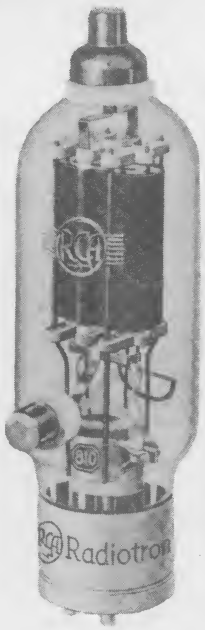
Only Minor Changes Needed in Transmitter

An important feature of the new RCA-810 is its suitability for the amateur who is now using tubes of the so-called "50-watt" class and who wishes to increase his power without completely re-building his transmitter, according to engineers of the RCA Commercial Engineering Division.

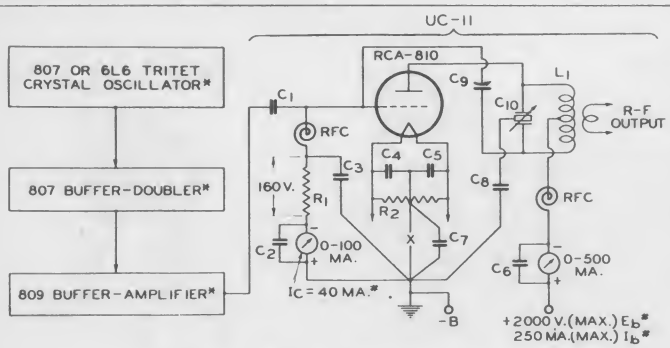
"In general," they explained, "this new tube can be used to replace a '50-watter' with only minor circuit changes, including the neutralizing adjustment. If the existing plate supply delivers only 1250 volts, but has ample current capacity, the higher plate-current rating of the RCA-810 can be used to increase the plate input from 220 to 310 watts. If the plate supply is changed so that it will deliver 2000 volts at 250 milliamperes, the power input can be increased from 220 to 500 watts, in class C telegraphy service.

"At the higher voltages, some additional driving power will be needed, but this can usually be obtained without any radical changes in the exciter and driver stages."

POWER TO SPARE!



The RCA-810 is a big, husky triode that has "what it takes." New design features give it outstanding performance while RCA manufacturing facilities bring it to you at the unusually attractive price of $13.50, Amateur Net.



MULTI-BAND CW TRANSMITTER
Power Output 375 Watts**

C_1 = 0.0005 μf, MICA, 1500 V.
C_2 TO C_6 = 0.002 μf, MICA
C_7 = 0.002 μf, MICA, 2500 V.
C_8 = 0.002 μf, MICA, 5000 V.
C_9 = 4.8 μμf (APPROX.), 7500 V.
C_{10} = 0.75 μμf/METER/SECTION†
R_1 = 4000 OHMS, 20 WATTS
R_2 = 50 OHMS, C.T., WIRE-WOUND
L_1 = SELECT FOR BAND DESIRED
RFC = R-F CHOKE
X = INSERT KEYING RELAY HERE

** Approximate.
* For this circuit, see "Ham Tips," Sept., 1938, or the RCA Transmitting-Tube Manual TT-3.
† Approximate capacitance in actual use at resonance.
# For plate-modulated telephony service, reduce E_b to 1600 V., I_b to 210 Ma., and increase Ic to 50 Ma. The power output is approximately 250 watts.

NEW HIGH-MU TRIODE REDUCES COST OF ONE K.W. AMATEUR TRANSMITTER

High Perveance Insures Excellent Plate Efficiency — Amateur Net Price $13.50 Each

A new high-power triode of traditional RCA quality and of unusually fine performance has just been announced by all RCA Power Tube Distributors. This tube, known as the RCA-810, is of the high-mu triode type and has a number of important design features that make it an exceptional value for the amateur who desires a high-powered rig.

Two RCA-810's in a push-pull circuit will deliver a 750-watt carrier for class C telegraphy and a 500-watt carrier for plate-modulated telephony. A feature of this new tube is its low driving-power requirements—a single RCA-809 operating as a frequency doubler will furnish ample excitation for one RCA-810.

Two RCA-810's in a class B modulator circuit operating at only 1500 volts, will deliver more than 500 watts of audio power—sufficient to modulate fully a final r-f stage running at an input of one kilowatt.

Has Thoriated Filament

This new triode, economically priced at $13.50, employs a number of new

(*Continued on page 2, column 1*)

NEW TUBES

RCA-1616

The RCA-1616 is a high-vacuum, half-wave rectifier tube of the coated filament type. It is quick-heating and is particularly useful in high-voltage devices where plate and filament voltages are applied simultaneously under full-load conditions. In single-phase circuits, full-wave rectification is obtained by using two of these types. Net price $5.75.

Tentative Ratings

Filament Voltage (AC)	2.5 Volts
Filament Current	5 Amperes
Peak Inverse Voltage	5500 *max.* Volts
Peak Plate Current	0.8 *max.* Ampere
Surge Current*	2.5 *max.* Amperes
Average Plate Current	0.13 *max.* Ampere

*Equipment should be designed so that this value is not exceeded during switching operation.

RCA-1623

The RCA-1623 is a three-electrode oscillator, r-f amplifier, and class B modulator tube having an amplification factor of 20. Except for a lower amplification factor, the RCA-1623 is similar to the RCA 809. The RCA-1623 employs a filament of the thoriated-tungsten type. As a self-excited oscillator in circuits which are subject to unusual conditions of wide plate-load variations, this tube is particularly useful because it is not critical to changes in grid excitation voltage. The 1623 has a maximum plate dissipation of 25 watts for class C telegraph and class B services and may be operated at maximum ratings at frequencies as high as 60 Mc. RCA-1623 has a ceramic base. Net price $2.50.

Tentative Ratings

Filament Voltage (AC or DC)	6.3 Volts
Filament Current	2.5 Amperes
Amplification Factor	20
Direct Interelectrode Capacitances:	
Grid-Plate	6.7 μμf
Grid-Filament	5.6 μμf
Plate-Filament	0.9 μμf

PRICES REDUCED!

Check the following reductions on RCA Power Tubes

TYPE	OLD NET PRICE	NEW NET PRICE
203-A	$15.00	**$10.00**
204-A	97.50	**85.00**
211	15.00	**10.00**
803	34.50	**28.50**
837	8.50	**7.50**
838	16.00	**11.00**
845	15.00	**10.00**
849	135.00	**120.00**
866-A	4.00	**2.50**
872	14.00	**9.00**
872-A	16.50	**11.00**

Here's your chance to get the finest quality in power tubes at new low prices. See your distributor at once.

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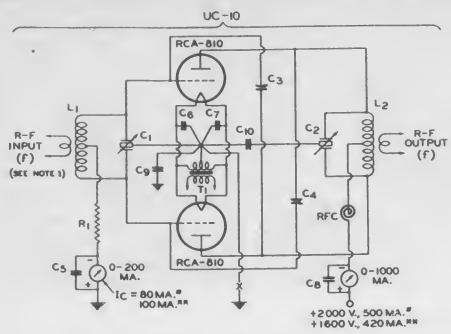
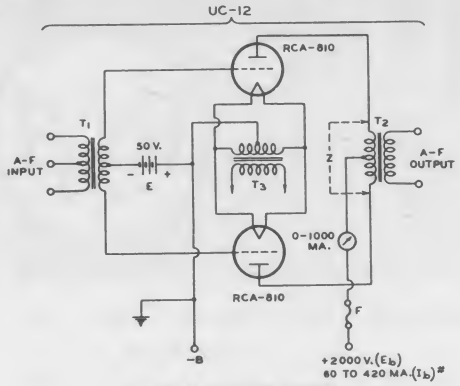
HAM TIPS from RCA



R-F AMPLIFIER, PUSH-PULL RCA-810's
Class C Plate-Modulated Telephony Power Output 500 Watts*
Class C Telegraphy Power Output 750 Watts*

C_1C_3 = 1.5 μμf/METER/SECTION†
C_6C_4 = 4.8 μμf (APPROX.), 7500 V.
C_5 TO C_8 = 0.002 μf, MICA
C_9 = 0.002 μf, MICA, 2500 V.
C_{10} = 0.002 μf, MICA, 5000 V.
R_1 = 2000 OHMS, 50 WATTS
L_1L_2 = TUNE TO FREQUENCY "f"
RFC = R-F CHOKE
T_1 = 10-V., 9-A. FIL. TRANSFORMER
X = INSERT KEYING RELAY HERE
* Approximate.
† Approximate capacitance in actual use at resonance.
# CW telegraphy.
** Plate-modulated telephony.

NOTE 1: R-f power output of driver stage should be about 40 watts# or 60 watts.**



CLASS B MODULATOR
A-F Power Output 590 Watts*

T_1 = INPUT TRANSFORMER; PLATE-TO-PLATE IMPEDANCE, 1500 OHMS(NOTE2)
T_2 = OUTPUT TRANSFORMER, Z = 11,000 OHMS
T_3 = 10-V., 9-A. C.T. FILAMENT TRANSFORMER
F = ¾ A. HIGH-VOLTAGE FUSE
* Approximate.
# From zero-signal to steady, full-signal conditions.

NOTE 1: With E_b = 1500 V., E = −30 V., Z = 6600 ohms, I_b = 80 to 500 Ma., and the power output is 510 watts.
NOTE 2: Four 2A3's in push-pull-parallel, Class AB_1, operating at E_b = 300 V. and E_c = −62 V. (fixed bias), are recommended for the driver stage.

Push-Pull RCA-810's Deliver 750 Watts To Antenna System

(*Continued from page 1, column 4*)

design features. One of these is the use of a heavy-duty thoriated-tungsten filament shielded at both ends, inside the graphite plate structure. This construction conserves input power by eliminating bulb bombardment and stray electrons. The grid lead is brought out to a husky metal cap at the side of the bulb. Such construction not only minimizes lead inductance and capacitance, but also improves insulation and simplifies grid-circuit wiring.

Has Graphite Plate

The sturdy graphite plate of the 810 shows only a barely perceptible red color at the maximum plate-dissipation rating for each class of service. Its neat mechanical structure makes this tube present that clean-cut appearance which adds to the eye-appeal of any transmitter and which is an inherent feature of all RCA Transmitting Tubes.

Circuit UC-11 shows two RCA-810's in a conventional class B modulator arrangement. This makes an economical modulator for a one-kilowatt amateur transmitter.

The new RCA-810 can also be used as a grid-modulated r-f amplifier or as a class B linear r-f amplifier, in which services it will deliver a carrier of about 60 watts.

Tentative Characteristics and Ratings

Filament Voltage (AC or DC)	10.0
Filament Current (Amperes)	4.5
Amplification Factor	35
Direct Interelectrode Capacitances:	
Grid-Plate	4.8 μμf
Grid-Filament	8.7 μμf
Plate-Filament	12 μμf

DO YOU KNOW THAT—

—RCA tubes are used by broadcast companies because of their reliability? (The average useful life of receiving tubes used by the National Broadcasting Co. is more than 10,000 hours.)

Typical Circuits for RCA-810 Show Suitable Wiring Constants

Push-Pull RCA-807's or Single RCA-809 Give Ample Driving Power for Final Amplifier

Three circuits illustrating typical applications of the 810 are shown in diagrams UC-10, UC-11, and UC-12. Recommended circuit constants are given in the legends.

Circuit UC-10 shows a push-pull r-f amplifier capable of almost perfect electrical and mechanical symmetry. A final amplifier stage of this type can be driven by a single 809 operating as a straight amplifier, or by two 807's in push-pull. Keying is shown in the filament-to-ground return lead. If it is desired to key the oscillator for break-in operation, a partial fixed bias of −45 volts should be used, in conjunction with a grid leak resistor (R_1) of about 1400 ohms. This amount of fixed bias will protect the 810's against removal of grid excitation when the key is open.

A suggested tube line-up for a multi-band transmitter is shown in conjunction with circuit UC-11, employing a single-ended 810 final amplifier. For 10-meter operation with an 80-meter crystal, the "Tritet" oscillator plate circuit is tuned to 40 meters, the 807 to 20 meters, and the 809 as a doubler to 10 meters. For 20-meter operation with a 40-meter crystal, the oscillator plate circuit can be tuned to 20 meters, the 807 used as a straight 20-meter amplifier to drive the 810, and the 809 stage "jumped" or omitted. Many other operating combinations are possible, depending on the crystal frequency and the desired output frequency.

The 809 stage is needed only for the 10-meter band where a 3.5-Mc. or a 7.0-Mc. crystal is to be employed. With a 10-meter crystal in a 6J5-G triode crystal oscillator, the 807 can be used to drive the 810 directly, thus providing a 3-stage, 10-meter transmitter of respectable power output.

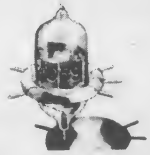
RCA-810
Maximum Ratings and Typical Operating Conditions
As R-F Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation

DC Plate Voltage	2000 *max.*		Volts
DC Grid Voltage	−500 *max.*		Volts
DC Plate Current	250 *max.*		Milliamperes
DC Grid Current	70 *max.*		Milliamperes
Plate Input	500 *max.*		Watts
Plate Dissipation	125 *max.*		Watts
TYPICAL OPERATION:			
DC Plate Voltage	1500	2000	Volts
DC Grid Voltage:			
From fixed supply of	−120	−160	Volts
From cathode resistor of	415	550	Ohms
From grid resistor of	3000	4000	Ohms
Peak R-F Grid Voltage	280	330	Volts
DC Plate Current	250	250	Milliamperes
DC Grid Current (Approx.)	40	40	Milliamperes
Driving Power (Approx.)	10	12	Watts
Power Output (Approx.)	275	375	Watts

RCA FILAMENT TYPE ACORN TUBES FB FOR U.H.F. UNITS

Three New RCA Tubes Ready for Experimenters



RCA-959

RCA-957, 958, and 959 are a new series of Acorn tubes having low-current filament cathodes. These tubes are designed particularly for use at the ultra-high frequencies in compact portable and other battery-operated equipment where economy of filament and plate power as well as size and weight are important factors.

The filaments are designed for 1.25 volts and can be operated without series resistance directly from a single flashlight dry-cell. The excellent performance of these Acorn tubes at ultra-high frequencies is due to an unconventional structure having small size, close electrode spacing, and short terminal connections.

RCA-957 is a triode having a moderately high amplification factor. It may be used as a detector, amplifier, and oscillator. Amateur net price, $3.00.

RCA-958 is a triode especially designed for transmitting service as an oscillator and radio-frequency amplifier. It may also be used as an audio power output tube to operate a sensitive loudspeaker. Amateur net price, $3.00.

RCA-959 is a sharp cut-off pentode well-suited for use as an r-f amplifier and detector. It may also be used as a resistance-coupled a-f amplifier. Amateur net price, $5.00.

Tentative Ratings and Characteristics

	RCA-957	958	959
Filament Volts	1.25	1.25	1.25
Filament Curr.	50 M.A.	100 M.A.	50 M.A.
Max. Plate Volts	135	135	135
Max. Sc. Volts	—	—	67.5
Grid Volts	−5	−7.5	−3
Plate Current	2 M.A.	3 M.A.	1.7 M.A.
Screen Current	—	—	0.4 M.A.
Plate Resistance (approx. ohms)	24,600	10,000	800,000
Transconductance (Micromhos)	650	1200	600
Amplification Factor	16	12	480

STURDY SOCKET

Here's a real socket for all "fifty-watt" size four-prong tubes such as RCA-810, 203-A, etc. Has a heavy glazed porcelain base and large wiping contacts. Model UT-541-A, Amateur Net Price, $1.75.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

HAM TIPS from RCA

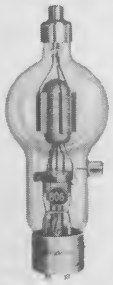
Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 1—No. 4 CAMDEN, N. J. DECEMBER, 1938

ONE-TUBE XTAL RIG GIVES 150-WATT OUTPUT ON C-W

RCA 806 IS TOPS FOR HIGH-POWER HAM TRANSMITTERS

New enclosed plate increases power at 30 megacycles



RCA-806

Always a leader with amateurs for high-powered transmitters, the RCA 806 is finding even greater favor because of numerous design improvements. A totally enclosed tantalum plate conserves power by eliminating losses from bulb bombardment and stray electrons. At 30 megacycles, this provides the user with 75 watts of additional useful power per tube. As a plate modulated r-f power amplifier, the RCA 806 has a power output of 390 watts per tube with a driving power of only 32 watts. As an r-f power amplifier and oscillator in Class C telegraph service, the power

(*Continued on page 2, column 1*)

For Television Experimenters

Again RCA gives Television Experimenters new tools for working out their problems. Two of the new Kinescopes have white screens for reproducing black and white pictures. The other one has a green screen and may be used for either television or oscilliographic work. The RCA-1899 Monoscope is used for producing test signals.

HIGH-POWER CRYSTAL OSCILLATOR A REALITY WITH RCA-813 TETRODE

May be plate-modulated with 60% efficiency for carrier output of 100 watts

The long-cherished amateur dream of a one-tube crystal-controlled 'phone or cw transmitter comes very close to being realized with the new RCA-813 beam power tetrode. In plate-modulated service, 100% modulation can be obtained with good linearity, low distortion, and a carrier output of 100 watts! In cw telegraphy service, excellent keying can be accomplished in the screen circuit and a power output of 150 watts can be obtained! In neither case is the r-f crystal current excessive.

The circuit used to achieve these truly remarkable results is the Reinartz tetrode crystal oscillator arrangement, shown in diagram UC-14. The data given above for plate-modulated operation was obtained at a frequency of 3990 kcs. The data for cw telegraphy was obtained at frequencies of 3510 kcs. and 7150 kcs., with 80- and 40-meter crystals, respectively. The

(*Continued on page 2, column 3*)

FOUR TELEVISION TUBES ANNOUNCED TO EXPERIMENTERS

Two Kinescopes provide black and white pictures

Three new Kinescopes and an improved Monoscope have just been made available to Amateurs and experimenters by all RCA Power Tube Distributors. These new tubes are:

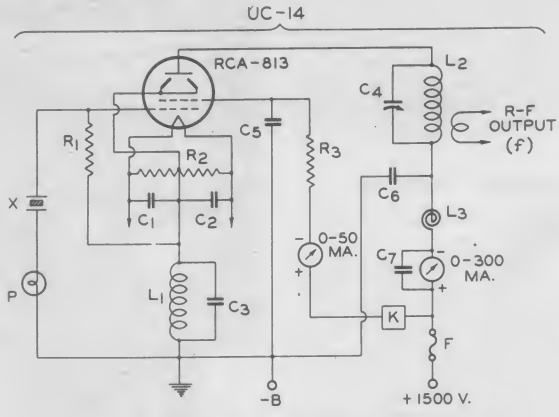
	Amateur Net
RCA 906-P4 KINESCOPE (3-inch Electrostatic-Deflection Type with White Phosphor)	$15.00
RCA 1802-P1 KINESCOPE (5-inch Electrostatic-Deflection Type with Green Phosphor)	23.75
RCA 1802-P4 KINESCOPE (5-inch Electrostatic-Deflection Type with White Phosphor)	27.50
RCA 1899 MONOSCOPE (Electromagnetic-Deflection Type)	95.00

Kinescope 906-P4 (similar to the well-known type 906) is a 3-inch cathode-ray tube which features a white fluorescent screen material for the black-and-white reproduction of television pictures. In addition to its low initial cost, this new type permits

(*Continued on page 2, column 1*)

Beam Tetrode

High-Power Sensitivity and a power output in Class C service of 260 watts make the RCA-813 an excellent tube for medium power rigs. Elimination of neutralization in adequately shielded circuits and a driving power of less than 1 watt are other important features.



One-Tube CW or 'Phone Transmitter

Plate-Modulated Telephony Power Output 100 Watts

CW Telegraphy Power Output 150 Watts

C_1, C_2, C_7 = 0.002 μf, MICA
C_3 = 0.0001 μf, MICA
C_4 = 1.5 μμf, PER METER
C_5 = 0.001 μf, 2000V. MICA
C_6 = 0.002 μf, 5000V. MICA
R_1 = 30,000 OHMS, WIRE-WOUND
R_2 = 50 OHMS, C.T., WIRE-WOUND
R_3 = 50,000 OHMS, 25 WATTS
L_1 = 100 TURNS No. 24 D.C.C. on 1¼" Diameter Form
L_2 = FOR FREQUENCY "f"
L_3 = R-F CHOKE, 250 MA. D.C.
F = ¼ A. HIGH-VOLTAGE FUSE
K = SEE NOTE
X = CRYSTAL, FREQUENCY "f"
P = 2.0-VOLT, 60-MA. PILOT LAMP

NOTE: "K" is a high-voltage keying relay, insulated for 2500 Volts. Do not use an ordinary key in this position under any circumstances.

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HAM TIPS from RCA

Four Television Tubes Announced To Experimenters

(*Continued from page 1, column 3*)

of low circuit cost due to the low voltage at which its Anode No. 2 can be operated—only 600 volts. This feature is the result of improved electron-gun construction and the use of a conductive inner-bulb coating. The conductive coating minimizes deflecting-plate loading and prevents drifting of the pattern with changes in control-grid bias.

Two 5-inch Kinescopes

Kinescopes 1802-P1 and 1802-P4 are 5-inch cathode-ray tubes of the double-electrostatic-deflection type. These tubes are similar except for their fluorescent screens. The 1802-P4 has the new white-fluorescent screen, while the 1802-P1 has the standard green screen. Both types have an improved electron-gun construction and a conductive inner-bulb coating. The 1802-P1, being designed for television as well as for oscillographs, is especially good for the latter application due to the brilliant pattern and small spot-size it produces. In either tube, the deflection sensitivity is such that the beam may be deflected across the entire screen with no more voltage than is required for full deflection on 3-inch cathode-ray tubes.

Improved Monoscope

Monoscope RCA-1899 is a special form of cathode-ray tube used mainly for testing the performance of television equipment. In the operation of this tube, an electron beam is made to scan a test pattern printed on an electrode located in the screen end of the bulb. As a result of secondary-emission effects produced by the scanning of the pattern, the tube generates a video signal. This signal, after amplification, is useful for testing television equipment and for demonstrating television principles.

RCA 806 Is Tops For High-Power Ham Transmitters

(*Continued from page 1, column 1*)

output is approximately 450 watts per tube with 20 watts driving power.

Supplementing its fine performance is the mechanical design of the RCA 806. The filament structure and grid assembly are both double collar mounted, while rugged supports prevent possible glass fractures. Every precaution has been made to make the RCA 806 an outstandingly sturdy high-powered tube. It's tops in performance and tops in construction.

The low net price of $22.00, plus the many fine features of this tube, is making it a great favorite for replacement use. Your RCA Parts Distributor will be glad to give you further details pertaining to this fine RCA tube.

Uses Pair RCA 813's

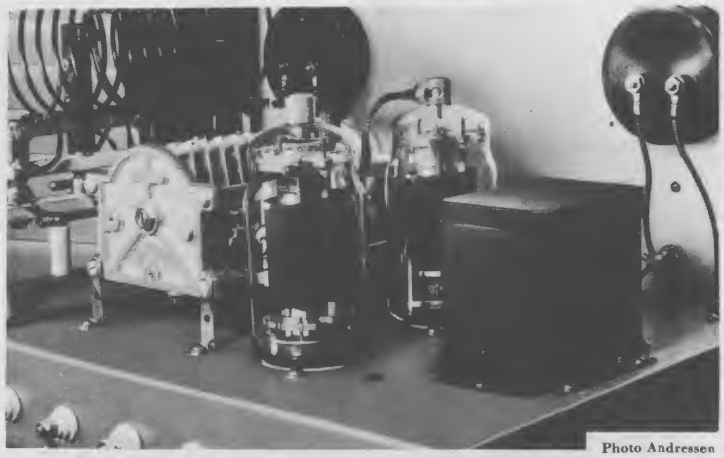


Photo Andressen

First prize winner in "Ham Tips" 100% RCA Tubed Transmitter photo contest is Richard T. Parks, Jr., of Alameda, California, owner of amateur radio station W6PHS. The illustration shows the final amplifier using push-pull RCA-813's.

two 806's in push-pull. Thus, the design of a high-power, band-switching transmitter for operation on the three lowest-frequency amateur bands (160, 80, and 40 meters) is greatly simplified, through the use of only two r-f stages.

TYPE RCA-813
CHARACTERISTICS AND RATINGS

Filament Voltage (AC or DC)	10.0	Volts
Filament Current	5	Amps.
Transconductance, For plate cur. of 50 ma.	3750	approx. Micros.
Direct Interelectrode Capacitances:		
Grid-Plate (With external shielding)	0.2 max.	μμf
Input	16.3	μμf
Output	14	μμf
Bulb	T-20	
Cap	Medium Metal	
Base	Giant 7-Pin Bayonet	

MAXIMUM RATINGS AND TYPICAL OPERATING CONDITIONS

As R-F Power Amplifier and Oscillator —Class C Telegraphy

	Key-down conditions per tube without modulation**		
DC Plate Voltage	2000 max. V		
DC Screen Voltage (Grid No. 2)	400 max. V		
DC Grid Voltage (Grid No. 1)	-300 max. V		
DC Plate Current	180 max. Ma		
DC Grid Current	25 max. Ma		
Plate Input	360 max. W		
Screen Input	22 max. W		
Plate Dissipation	100 max. W		
Typical Operation:			
DC Plate Voltage	1250	1500	2000 V
DC Screen Voltage	300	300	400 V
DC Grid Voltage*	-60	-70	-90 V
Peak R-F Grid Voltage	145	150	160 V
Beam-Forming Plate Voltage#	0	0	0 V
DC Plate Current	180	180	180 Ma
DC Screen Current	23	20	15 Ma
DC Grid Current (Approx.)	7	6	3 Ma
Screen Resistor	42000	60000	107000 Ω
Grid Resistor	8500	11700	30000 Ω
Driving Power (Approx.)	1	0.8	0.5 W
Power Output (Approx.)	155	190	260 W

* Grid voltages are given with respect to the mid-point of filament circuit operated on AC. If DC is used, each stated value of grid voltage should be decreased by 7 volts and the circuit returns made to the negative end of the filament.

Beam-forming plates should be connected to the mid-point of filament circuit operated on AC, or to the negative end of the filament when a DC filament supply is used.

**Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

V-CUT CRYSTALS

Greatly Reduce Frequency Drift

Unusually high-power output, plus an extremely low temperature coefficient, make the RCA V-Cut Crystals ideal for amateur use. Crystals are supplied within 0.1% of specified frequency and are calibrated to an accuracy of 0.005% at calibration temperature. Temperature coefficient is 4 cycles or less per million per degree of centigrade on all bands. They are ideal for operation at the edge of amateur bands where extreme stability is required. RCA V-Cut Crystals are not to be confused with the usual amateur-type crystal and are supplied and calibrated on order only. Your RCA Amateur Equipment Distributor will be glad to furnish these units at the following prices, which include holder and calibration. (Allow two weeks for delivery after your distributor has placed order with us.)

	Amateur Net
160, 80 and 40-meter band crystals	**$18.00**
20-meter band crystals (up to 15 megacycle for doubling to high frequency end of 10-meter band)	**22.00**

RCA SOCKETS

Sturdy, well-built RCA sockets are available for many Transmitting tubes. These sockets are manufactured by RCA and are built to the same high standards employed in RCA Transmitting Tubes.

		Amateur Net
UT 541-A	for RCA 203-A, etc.	**1.75**
UT 103	for RCA 833 only	**12.50**
UT 102-A	for RCA 803 only	**2.25**
UT 1085-6	for RCA 204-A, etc.	**4.65**
UT 104	for RCA 813 only	**1.25**

One-Tube Rig Has 150-Watt Output on C-W

(*Continued from page 1, column 4*)

results on 40 meters were the same as those on 80 meters. The same circuit constants can be used for either cw or head 'phone operation.

Easily Keyed Without "Chirping"

When the screen circuit is keyed, a receiver test shows that a clean-cut signal is obtained with no noticeable "chirping." This excellent keying characteristic is due to the fact that, with the key open, the crystal continues to oscillate feebly; thus, when the key is closed, the crystal starts off on the same frequency without causing chirps. The antenna load should not be coupled too tightly, as this may cause the crystal to stop oscillating when the key is up. Proper loading can be obtained, with correct circuit adjustments, without stopping the key-up oscillations. In order to key the high-voltage screen circuit safely (as regards the *operator*), it is absolutely essential to employ a suitable high-voltage keying relay, insulated for 2500 volts. *Under no circumstances* should an ordinary manual key be used in the screen circuit.

Operating Conditions

The operating conditions for circuit UC-14 are as follows:

For plate-modulated telephony; d-c plate voltage, 1500 volts; plate current, 111 ma.; screen current, 15 ma; d-c grid current, 5 ma; r-f crystal current, 61 ma; plate input, 167 watts; carrier output, 100 watts; and plate efficiency, 60 per cent.

For cw telegraphy; plate voltage, 1500 volts; plate current, 162 ma; screen current, 18 ma; d-c grid current, 7 ma; r-f crystal current, 14.2 ma; plate input 244 watts; carrier output, 150 watts; and plate efficiency, 61.5 per cent.

The 813 as a high-power crystal oscillator can be used to drive a plate-modulated one-kilowatt final amplifier stage directly—for example,

Colorful Carton

The new carton for RCA Power and Special Purpose Tubes is an unusually attractive four-color job. Look for it the next time you buy tubes for your amateur rig.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligations.

Form No. 4142

Printed in U.S.A.

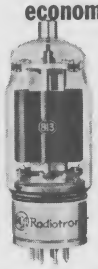
HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 2—No. 1 CAMDEN, N. J. JAN.—FEB., 1939

RCA-813 CREATES UNUSUAL INTEREST AMONG AMATEURS

Offers circuit simplicity and economy of operation



RCA-813

Not so long ago, the announcement of a new amateur transmitting tube was something of an event—a topic for general discussion. Today, new amateur tubes are announced so frequently that a new type has to be really outstanding to create more than a temporary ripple of interest. Such an outstanding tube is the new high-power beam tetrode, type RCA-813. It is difficult to say if the almost over-night popularity attained by the 813 is due to its amazingly low driving power requirements, its adaptability to band-switching transmitters, its high power output at moderate plate voltages, its operation without need for neutralization, or to its clean-cut, compact mechanical design. In any event, the popularity of this new "r-f factory" in Hamdom is increasing at an unprecedented rate.

Uses Simple Circuits

In general, the circuits recommended for the RCA-813 are basically no different from the circuits commonly used for other beam tetrodes, such as the 807 and 814. Diagram UC-15 shows the circuit for a plate-and-screen-modulated 813, with constants. In this circuit, it will be noted that the plate-circuit by-pass condenser C_6 is connected to ground in series with the screen by-pass, C_5. This arrangement minimizes the by-passing effect of C_5 at high audio frequencies, and thus greatly improves the modulation of the screen voltage. Because the screen impedance of the 813 is about 20,000 ohms, and the series screen resistor required is 60,000 ohms, the ratio of C_5 to C_6 should be about 3 to 1, as indicated in the legend. For operation at 3.5 Mc. and lower frequencies, it may be desirable to increase the values of C_5 and C_6, keeping their ratio the same.

Class C Operation

In class C telegraphy service, where the grid excitation or the cathode circuit of the 813 is to be keyed, it is important that the screen voltage be

(*Continued on page 2, column 4*)

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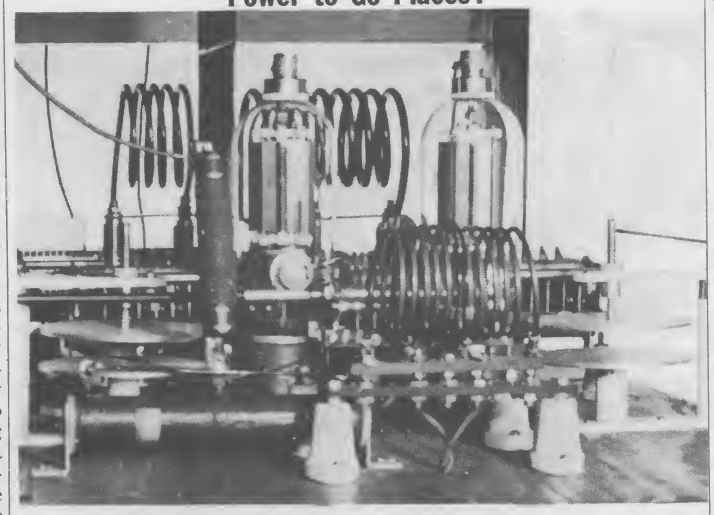
Power to Go Places!



W2AMP sent in this photograph of his formidable-looking final, using a pair of the new RCA-810's. He says: "The new bottles replace two 203-A's that I had been using. This change enables me to run up to a kilowatt with ease—and all the way down to ten meters. The only readjustments I had to make in the whole transmitter were those involving reneutralizing and the moving of the plate and grid leads from the socket to the caps on the 810's."

ARRL FIELD DAY WON BY W9AIU WITH RCA-802'S IN ALL CW RIGS

RCA-807 used for final amplifier of 'phone transmitter with 15 watts input

The Egyptian Radio Club of Granite City, Illinois, using the club call W9AIU, recently won the A.R.R.L. 1938 Field Day Contest with an all-time high in Field Day scores of 3708 points, leading the contest for the second consecutive year. W9AIU was operated on Chouteau Island, across the Mississippi River from the northern city limits of St. Louis, Mo. Contacts made on 1.75-Mc. 'phone and 3.5-, 7-, and 14-Mc. cw. totaled 317. Of the 317 QSO's, 85 were with other portable stations.

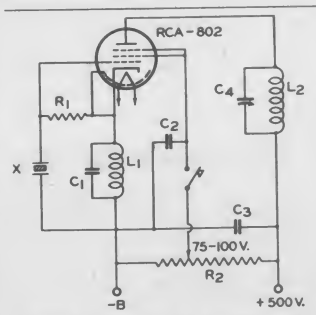


Figure 1—Circuit of portable cw transmitters used at W9AIU-9

C_1 = 0.0001 μf, mica
C_2 = 0.01 μf, mica
C_3 = 0.006 μf, mica
C_4 = 1.2 μμf/meter
R_1 = 5000 ohms, wire-wound
R_2 = 25,000 ohms, 25 watts
L_1 = 40 turns No. 24 D.C.C. on 1½"-diameter form, close wound
L_2 = Suitable for frequency desired
X = Crystal for frequency desired

Each of four cw. transmitters consisted of an RCA-802 in the Reinartz tetrode crystal-oscillator circuit (shown in Fig. 1) with an input of 12 to 18 watts. 'Phone operation started with a 6C5-6L6 combination; this rig was later replaced by a three-stage affair using an RCA-807 final amplifier with 15 watts input. The modulator was a 6N7 in class B. Seven separate receivers were used. Half-wave, end-fed antennas were used for 1.75 and 3.5 Mc. Two 7-Mc. doublets placed at right angles and using EO-1 cable for feeders served for the 40-meter

(*Continued on page 2, column 2*)

COMPACT DESIGN IS FEATURE OF RCA-921 AND 922

New Double-Ended Phototubes Have Excellent Characteristics

RCA-922

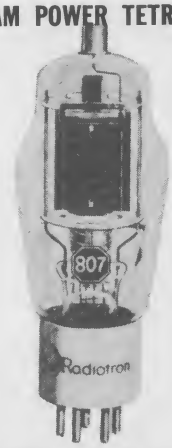
The recent announcement of the RCA-921 and 922 Phototubes have created unusual interest among experimenters. These tubes have low inter-electrode capacitances and high sensitivity. The RCA-921 is a gas-filled tube while the RCA-922 is of the vacuum type. Both are extremely sensitive to red light and infra-red radiation, making them particularly well suited for use with incandescent light sources.

Simple Light-Operated Relay

The RCA-922 is well suited to the simple light-operated relay unit shown in Figure 2. The relay in this circuit opens on an increase in light on the phototube. The change in light which is to actuate the relay can be very small but should last not less than one-tenth of a second. The circuit operates directly on the AC line without necessity of a rectifier.

(*Continued on page 2, column 4*)

POPULAR-PRICED BEAM POWER TETRODE



The RCA-807 having the low amateur net price of only $3.50 is an outstanding favorite with amateurs everywhere. Because of its high-power sensitivity, it may be used in a wide variety of amateur applications.

HAM TIPS from RCA

LETTERS TO THE EDITOR

High Perveance!

Dear Sirs:

I am an amateur radio operator, and have a wife and two children who think I am a little touched in the head because of my radio activities. Even though they think I am a little touched they have not bothered me until the last week. Now my wife and children are planning on leaving me and it is all because of my increased enthusiasm in the past week.

It has always been my policy to use RCA Tubes whenever possible. Of course when I decide to buy a new tube I investigate the characteristics of the tube in mind before making the purchase. Approximately a week ago I decided to buy a pair of RCA 810's, and went through the various informations available in order to acquaint myself with the tube. When I came to a phrase which stated that the tube had unusually high PERVEANCE I said to myself, "Son, there is a jug," then spent the next seven days and nights trying to find out what PERVEANCE meant. I have exhausted the patience of the local newspapers, libraries, and universities not to mention my wife and children, in a vain attempt to find out just what kind of a tube it is that has a PERVEANCE.

Now, gentlemen, here is the situation, you either send me the definition of that word or I absolutely refuse to ever buy a tube that has a PERVEANCE.

Yours very PERVEANCELY,
W9PTI

P.S. My wife's attorney just notified me they were giving me ten days more before filing her suit.

Dear W9PTI:

Far be it from us to do anything that would affect your marital bliss. As a matter of fact, we are married ourselves. So, just to make sure we are right, I have cornered one of our No. 1 engineers (he's married, too) and explained to him how important it was that we find out what "Perveance" means. You see, I didn't know either. Here's what he told me:

"RCA Power Tubes are high-perveance tubes, because high perveance saves you money.

"Why?

"Because it is the important electrical property that is actually a factor of merit or "goodness" of a tube.

"The perveance of a tube depends upon such things as the area of the cathode surface, the closeness of spacing between electrodes and the pitch and wire size of the grids. For a given set of electrode voltages, the higher the perveance, the higher will be the plate current, transconductance, and power output.

"From your standpoint, it is desirable to use a tube that has as high a perveance as possible. Higher-perveance tubes are more difficult to design, engineer and manufacture, but RCA Tubes are high-perveance tubes! A good example of a tube having high perveance is the new RCA-810. With a plate voltage of only 2,000 volts, it has a power output of 375 watts and requires only 12 watts of driving power."

Here's hoping the above explanation squares this up for you.

Hopefully,
Your Editor.

Likes 810!

Dear Om's,

I must hand you a big bouquet on the RCA-810 Tube just released. It is superb!

Now, for the first time, I have a really simple one kw. input, always at twice the crystal frequency. The oscillator is an RCA-1610, the doubler uses parallel RCA-1608's and the final push-pull is a pair of RCA-810's. Boy, what a rig! And this is done with only 2000 volts DC, which is relatively simple to insulate compared with the previously used 5000 volts.

Many thanks for a big step forward. 73.

John B. Morgan
W3QP
Blue Bell, Pennsylvania

Field Day Won With CW Rigs Using RCA-802's

(*Continued from page 1, column 3*)

work. Two similar 14-Mc. doublets took care of 20-meter operation.

Power Supplied By Gasoline-Driven Alternator

Power was supplied by a 1500-watt, 220-volt, three-phase, gasoline-engine-driven alternator. Step-down transformers on each phase provided 110-volt, 60-cycle AC. This alternator was placed 200 feet from the receivers in order to reduce noise. An advantage of this type of power supply was that it could be used for lights, soldering irons, etc., as well as for station operation. A staff of 19 operators participated at W9AIU-9.

The following comments received from the E.R.C. explain their preference for the RCA-802 for use in their portable cw. transmitters:

"Several years ago Mr. Reinartz visited St. Louis demonstrating his crystal osc. circuit using the 802 tube, and to say that the thing was a hit with the gang here is putting it mildly. Since then, the Egyptian Radio Club has built and maintained several of these oscillators for emergency use and, of course, they get a real work during the A.R.R.L. Field Day contest each year. We have found that the RCA-802 used in this circuit is by far the most reliable and flexible portable transmitter it is possible to build. Changing bands is simplicity itself by merely placing the proper crystal and coil in their holders and tuning with the aid of the meter or an r-f indicating device. With the use of keying filters and antennas properly placed it was possible for us to operate four of these transmitters simultaneously, one in the 20-meter cw. band, two on 40 and one in the 80-meter cw. band.

Band-changing Made Easy

"...Twenty-, forty-, and eighty-meter crystals are used for efficiency and quick band-change adjustment. Keying is accomplished by breaking the screen voltage from the bleeder on the power supply. No trouble of any kind was had with these transmitters despite the fact that two of the RCA-802's had seen service in two previous Field Day Contests with plenty of station operation in between."

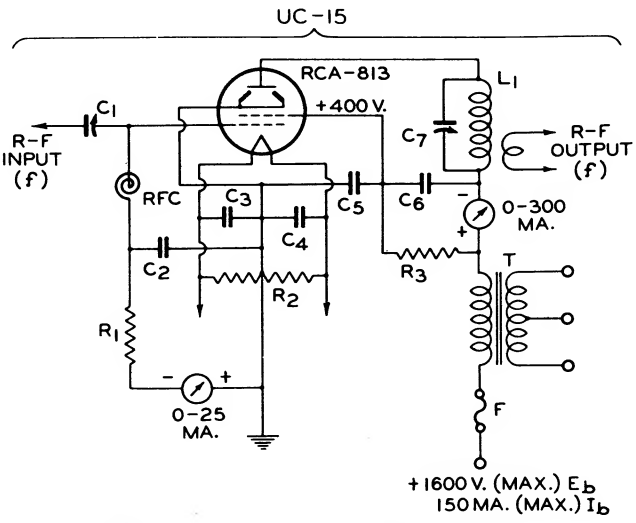


Plate-Modulated Class C R-F Power Amplifier
Power Output 175 Watts*

C_1 = 2 μμf/meter*
C_2, C_4 = 0.002 μf (or larger) mica
C_3 = 0.006 μf (or larger) mica, 2000 V.#
C_5 = 0.002 μf (or larger) mica, 5000 V.#
C_7 = 1.2 μμf/meter†
R_1 = 22,000 ohms, 2 watts
R_2 = 50 ohms, c.t., wire-wound
R_3 = 60,000 ohms, 50 watts
L_1 = For frequency "f"
RFC = R-f choke
T = Modulation transformer; secondary Z = 9500 ohms
F = ¼ A. high-voltage fuse
* Approximate.
# Ratio of C_5 to C_6 should be kept approximately .3 to 1.
† Capacitance in actual use.

RCA-813 Creates Unusual Interest Among Amateurs

(*Continued from page 1, column 1*)

obtained from a separate, low-voltage source, or from a tap on a bleeder circuit across the plate supply. It should not be obtained through a series resistor as shown in the plate-modulated-telephony circuit, UC-15. With the series-resistor method, the DC screen voltage will rise to the plate potential when the space current is reduced to zero. This voltage, of course, greatly exceeds the maximum screen-voltage rating. When the DC screen voltage is limited to approximately 400 volts under key-up conditions, a fixed grid bias of 45 or 50 volts is adequate to reduce the plate current to a safe value; partial fixed bias is recommended, therefore, in cw. transmitters where the oscillator stage is to be keyed for break-in operation. The remainder of the required grid bias can be conveniently obtained from a grid leak.

Because of its extremely low driving-power requirements—less than one watt in most types of service—the RCA-813 greatly simplifies the design of an exciter unit for a quick-band-change transmitter.

Compact Design is Feature of RCA-921 and 922

(*Continued from page 1, column 4*)

To adjust the circuit for a maximum sensitivity, first short-circuit C_2 and set R_3 so that plate current of the 25A6 is slightly larger than the value which closes the relay. Then remove the shorting connection from C_2, adjust the illumination on the phototube to the highest value at which it is desired that the relay stay closed, and move the pointer on R_3 toward the cathode of the 75 until the relay is on the verge of opening. The adjustment is then complete. With this adjustment, the relay will

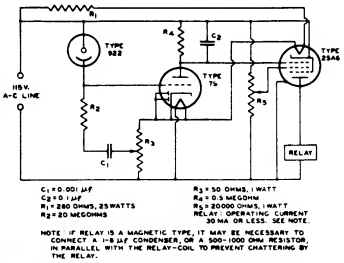


Figure 2—Simple light-operated relay circuit

open on a very small increase in light on the phototube.

Editor's Note: The above circuit and description is one of several shown in the RCA Technical Bulletin on the RCA-922 Phototube. These bulletins are available from your RCA Power Tube Distributor on practically all types of RCA Power and Special Purpose Tubes. Ask for a free copy pertaining to tube types in which you are interested.

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Form No. 1A118

HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 2 — No. 2 CAMDEN, N. J. MARCH—APRIL, 1939

VERSATILE OPERATION BRINGS POPULARITY TO RCA-807

FREQUENCY EASILY CHECKED WITH RCA XTAL CALIBRATOR

Accuracy better than 0.05%—Temperature correction given

By H. J. SCHRADER
RCA Engineering Department

H. J. SCHRADER

Recent rules of the F.C.C. require that the radio amateur periodically check his operating frequency to insure that it is within one of the assigned bands. This measurement must be made with equipment independent of the frequency control of the transmitter and of sufficient accuracy to always insure that he is operating within the assigned band. This accuracy may be quite readily obtained by employing the RCA Stock No. 9572 Piezo Electric Calibrator to check the accuracy of the amateur bandspread receiver or heterodyne frequency meter.

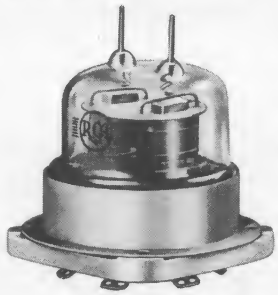
The Stock No. 9572 Piezo Electric Calibrator has a guaranteed accuracy of 0.05% and will maintain this accuracy over a wide range of temperatures. Still greater accuracy may be obtained by measuring the operating temperature of the unit and applying a temperature correction factor. Each instrument has been individually calibrated at the factory against frequency standard equipment having an accuracy of measurement of better than 1 part in a million.

Has Two Frequency Modes

The instrument has two fundamental modes of operation: one at 100 kcs., and the second at 1000 kcs. Either of the fundamental modes may be selected at will by means of a toggle switch located on the front of the instrument case. Because of the design of the associated tube circuit, an abundance of harmonics of either of these modes of oscillation are contained in the output of the

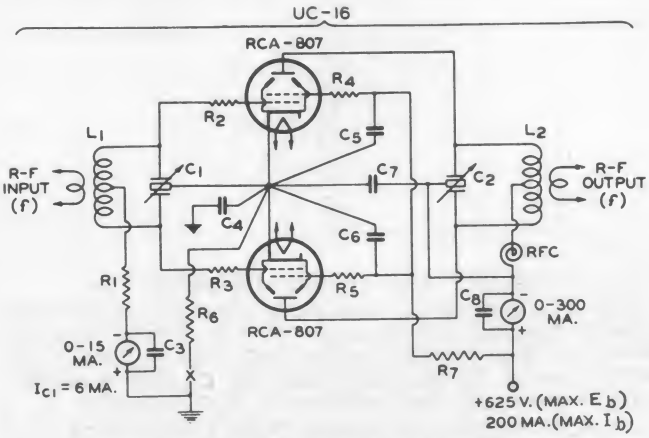
(*Continued on page 4, column 3*)

RCA-832 SOCKET



Unusually low dielectric losses, through use of a glazed Steatite Base is an important characteristic of the new RCA-UT-106 Socket, recently announced. This new socket carries the amateur net price of $1.50 and makes possible the full utilization of the ultra-high frequency performance characteristics of the RCA-832. An aluminum tube shield is included as shown above, which is mounted directly above the metal chassis, while the socket is held below by the same mounting screws or rivets. The UT-106 Socket contacts utilize cadmium-plated wipers with steel spring pressure clamps. They are turn-proof and have short by-pass connections.

See this new socket at your RCA Amateur Equipment Distributor's at $1.50 net, complete with aluminum shield.



PUSH-PULL BEAM POWER R-F AMPLIFIER

For Class C Telegraph Service
Power Output 75 Watts*

C_1 = 1.5 μμf/meter/section*
C_2 = 2 μμf/meter/section † (see Note 2)
C_3, C_8 = 0.002 μf mica
C_4, C_5, C_6, C_7 = 0.005 μf mica, 1000 V.
R_1 = 4200 ohms, 1 watt
R_2, R_3, R_4, R_5 = 50-ohm carbon, 0.5 watt #
R_6 = 110 ohms, 20 watts
R_7 = 19,500 ohms, 20 watts
L_1, L_2 = For desired frequency
RFC = R-f choke
X = Keying relay
* Approximate.
† Capacitance in actual use.
# Parasitic suppressors.

NOTES.—(1) This circuit is not suitable for keying in the oscillator stage—see text.

(2) Rotor shaft of C_2 is at d-c plate potential; an insulated coupling must be used between rotor shaft and control dial.

BEAM POWER TETRODE IS EXCELLENT FOR MANY AMATEUR APPLICATIONS

Push-pull R-F Amplifier produces output of 75 watts in Class C Service

Few other amateur tubes have received as much publicity in the way of published circuits and suggested applications as the RCA-807. Yet, the popularity of this versatile beam power tube is such that scarcely a day passes when new requests for circuit information are not received. This is not surprising in view of the fact that the 807 can be used in almost every type of amateur service imaginable. Crystal oscillator, doubler, quadrupler, buffer, plate- or grid-modulated r-f amplifier, modulator—the 807 fits them all.

Tritet crystal oscillator and single-ended r-f amplifier circuits for the 807 were shown in the September and October (1938) issues of *Ham Tips*. In this issue, circuit UC-16 shows an r-f amplifier using push-pull 807's and designed for class C telegraph service. This amplifier, producing an output of about 75 watts, is also useful as a buffer to drive a more powerful final amplifier, such as push-pull 808's, 810's, 805's, and similar types. Neutralization at frequencies up to 30 Mc. is not necessary in a properly designed stage.

Uses Cathode Keying

Circuit UC-16 is designed for *cathode keying*. It is not suitable for break-in operation where the r-f excitation (oscillator) is keyed, because grid leak bias is employed. Removal of the grid excitation would, of course, cause the plate current to "soar," with resultant overheating of and damage to the tubes.

If it is desired to key the oscillator, the screen voltage for the 807's should be obtained from a separate, 275-volt source having good regulation, in place of the series resistor, R_7. Thus, with a partial cathode bias of 25 volts, developed across R_6, the actual screen voltage (measured between screen and cathode) will be 250 volts. In addition, the grid leak (R_1) should be replaced by a fixed-bias source of about −30 or −35 volts; this can conveniently be obtained from a battery or from a bias rectifier.

(*Continued on page 4, column 1*)

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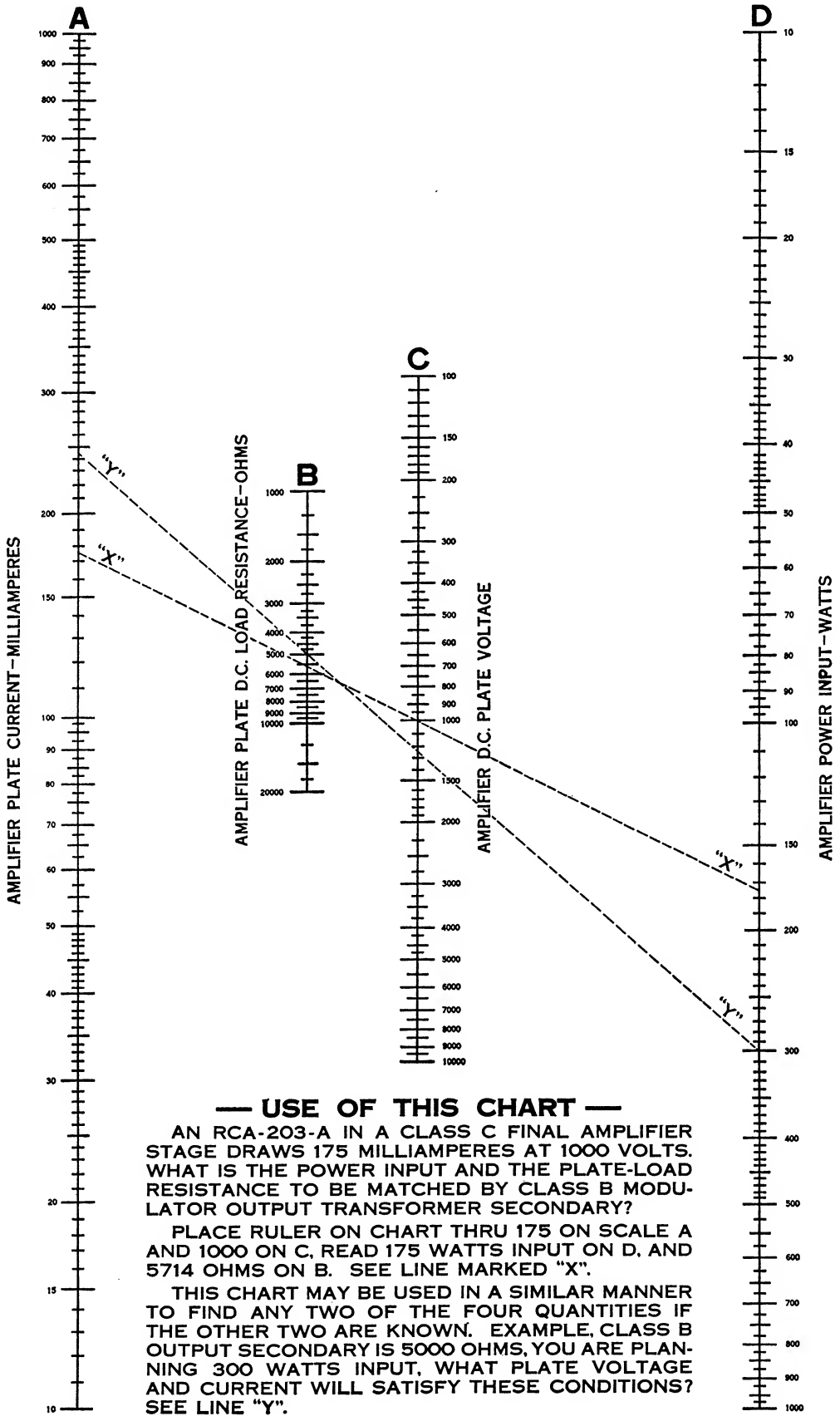
HAM TIPS from RCA



— USE OF THIS CHART —

AN RCA-203-A IN A CLASS C FINAL AMPLIFIER STAGE DRAWS 175 MILLIAMPERES AT 1000 VOLTS. WHAT IS THE POWER INPUT AND THE PLATE-LOAD RESISTANCE TO BE MATCHED BY CLASS B MODULATOR OUTPUT TRANSFORMER SECONDARY?

PLACE RULER ON CHART THRU 175 ON SCALE A AND 1000 ON C, READ 175 WATTS INPUT ON D, AND 5714 OHMS ON B. SEE LINE MARKED "X".

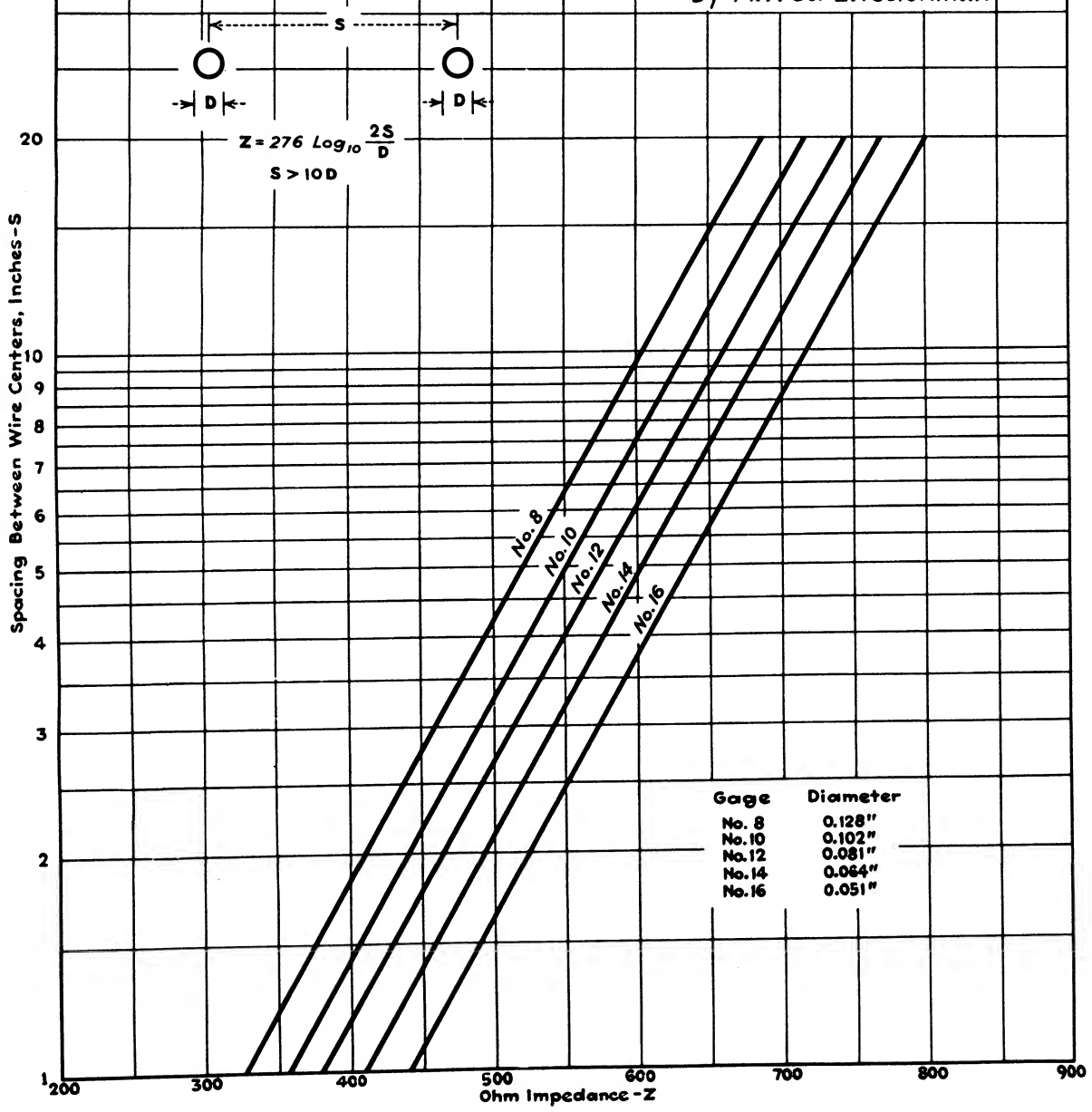
THIS CHART MAY BE USED IN A SIMILAR MANNER TO FIND ANY TWO OF THE FOUR QUANTITIES IF THE OTHER TWO ARE KNOWN. EXAMPLE, CLASS B OUTPUT SECONDARY IS 5000 OHMS, YOU ARE PLANNING 300 WATTS INPUT, WHAT PLATE VOLTAGE AND CURRENT WILL SATISFY THESE CONDITIONS? SEE LINE "Y".

W8UR

Impedance Chart for R-f Lines

The surge impedance of parallel-wire lines in terms of wire diameter and spacing, when the spacing is greater than ten times the wire diameter

By Alfred E. Teachman



Courtesy of "Electronics"

HAM TIPS from RCA

QUESTIONS AND ANSWERS

by RCA's Engineering Department

(Q) Why is a series screen resistor not recommended for the 814 in class C telegraph service?

A. Because, under key-up conditions where the space current is reduced to zero or to a low value, there is not enough IR drop across the screen resistor to limit the screen potential to a safe value. For example, where the tube is keyed in the filament-ground circuit, the screen current is zero when the key is up and the screen voltage therefore rises to the plate potential. The screen voltage should be obtained from a separate, low-voltage fixed source, or from a tap on a voltage divider. With the type of keying circuit mentioned above, the voltage regulation of the screen supply need not be especially good. It is permissible for the screen voltage to rise, under key-up conditions, to a value equal to twice the maximum rated screen voltage. In the case of the 814, this would be 600 volts under key-up conditions. The same statements apply to the big beam power tube, type RCA-813. They do not apply to the 807, which may be keyed in the cathode circuit with the screen voltage taken from the plate supply through a suitable series resistor (see circuit UC-16).

(Q) When the oscillator stage is to be keyed for break-in operation, how should the screen voltage for the 813 be obtained?

A. From a separate, low-voltage fixed source having good regulation, if it is desired to use the minimum amount of fixed grid bias to cut off space current when the key is up. It is mainly the screen voltage of a beam power tetrode which determines the cut-off bias required, the plate voltage being relatively unimportant. The screen voltage can also be obtained from a tap on a voltage divider across the high-voltage supply; however, if the voltage divider has poor regulation (too small a value of bleeder current), a larger amount of fixed grid bias will be required to obtain cut-off when the key is up. The proper cut-off bias for *rated* screen voltage can be obtained readily from the plate-family curves. These statements also apply to the 807 and 814.

RCA-807 Excellent For Variety Of Amateur Uses

(Continued from page 1, column 4)

The use of fixed grid bias without a fixed screen voltage would be unsatisfactory, because plate current cut-off could not be obtained with a reasonable value of grid bias. A good r-f choke, by-passed on the "ground" end, should be inserted between the center tap of L_1 and the bias supply, in order to avoid double r-f grounds in the grid circuit.

The 50-ohm carbon resistors in the grid and screen circuits (R_2, R_3, R_4, and R_5) may be helpful in preventing parasitic oscillations. If no parasitics are encountered, these resistors should be omitted.

Layout Important

The mechanical layout of the r-f amplifier is almost as important as the circuit itself. The tuned grid circuit (both L_1 and C_1) should be carefully shielded from the output circuit. Tube shields extending from the chassis to about 2/3 the height of the 807's should be employed. Some of the early receiving-tube shield cans will be found suitable.

When "tuning up" the 807 stage the first time, it is very advisable to insert a protective resistor of 3000 to 5000 ohms in series with the common positive high-voltage lead. This resistor will reduce the plate current and voltage to a safe value while the plate tank is out of resonance.

Changes Necessary for Plate Modulation

If it is desired to use plate modulation with circuit UC-16, the following changes should be made: R_6 = 130 ohms, 20 watts; R_7 = 14,000 ohms, 20 watts; Eb = 500 volts, maximum; Ib = 166 ma., maximum; and a 0.01-μf, 600-volt paper condenser should be shunted directly across R_7, in order to compensate for the audio-frequency by-passing of the screen condensers, C_5 and C_6. With these changes, the carrier power output will be approximately 50 watts. The secondary impedance of the modulation transformer should be about 2600 ohms, allowing for modulation of both screen and plate circuits. 100% modulation with excellent linearity can be obtained with a modulator having an a-f power output of about 40 watts.

HAS RANGE FROM 30 TO 15,000 CYCLES

For running fidelity curves or tone modulating your rig, the RCA Beat Frequency Oscillator is FB. At all RCA Test Equipment Distributors for $49.95 amateur net. Stock No. 154.

Frequency Easily Checked With RCA XTAL Calibrator

(Continued from page 1, column 1)

instrument. With a normal receiver and operating on the 100 kc. mode, harmonics up to 18 mc. may be readily detected. The 1000 kc. connection provides harmonics well above 40 mc.

The measurement of the transmitter operating frequency is made by first calibrating the dial on the receiver or heterodyne frequency meter against the piezo electric calibrator at 100 kc. intervals and then using the receiver or frequency meter to measure the transmitter frequency. The receiver or frequency meter should, of course, have either a

RCA Piezo-Electric Calibrator

straight-line frequency tuning condenser or a dial calibrated in frequency which compensates for the plate shapes. Also, it must have sufficient bandspread to read frequency to the required accuracy.

Recommends Frequent Checks

The majority of receivers and heterodyne frequency meters do not have sufficient stability with respect to changes in humidity and temperature to maintain accurate calibration over long intervals of time so the calibration should be made at frequent intervals, preferably before each measurement of the transmitter frequency. The calibration is readily accomplished by simply coupling the piezo electric calibrator to the antenna input of the receiver and tuning the receiver to the harmonic outputs of the unit. The variation between the marked frequency and the actual tuning point should be noted and a dial correction curve plotted. Having done this, the amateur has available a frequency meter of greater accuracy than most commercial instruments.

Faradon Facts

An oscillatory circuit has three fundamental physical components, namely: inductance, resistance and capacitance. These basic elements are employed in a number of ways to acquire circuit functions. Each element contributes in its own manner to the overall circuit efficiency. To achieve the ultimate in efficient circuit performance each of these three basic elements should exist as individual qualities to the exclusion of characteristics of the other two

Faradon Model T Condenser. Made of clear mica, sealed to prevent climatic changes. Sixteen sizes available from .00005 mfd. to .01 mfd., priced from 40 to 85 cents. See your RCA Amateur Equipment Distributor.

elements. For example, an inductance should be free of the resistive and capacitive elements; a resistor should have no inductive or capacitive qualities; a condenser should have no inductance or resistance. Man's skill has not been able to achieve the ultimate in design because of limitations in usable materials.

However, for all practical purposes, it behooves one, when buying a by-pass, blocking or coupling condenser for radio frequency currents to seek a brand that uses the finest of materials and employs the greatest degree of skill in its construction. Such a condenser is a FARADON—manufactured by RCA. Many years of usage in commercial radio equipment where exacting requirements are met is conclusive evidence of its superior design.

Your RCA Amateur Equipment dealer will be glad to show you many types of FARADONS that will improve that new transmitter you are building.

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Form No. 1A305

HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 2 — No. 3 CAMDEN, N. J. MAY—JUNE, 1939

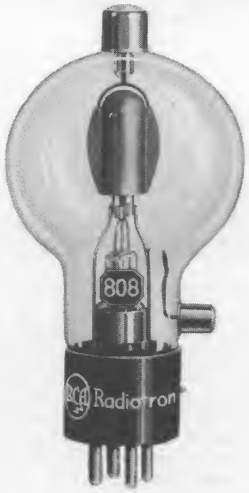
REINARTZ TAKES POSITION WITH U. S. NAVY DEPT.

Will Administer Field Activities of N. C. R.

Mr. J. L. Reinartz, who for the last few years has been associated with RCA as technical consultant on amateur tube applications, recently left RCA to take on new work with the U. S. Navy Department. As liaison officer for the Naval Communications Reserve, in the office of the Director of Naval Communications, he will administer the field activities of this organization from Washington.

Radio amateurs from coast to coast will remember the many interesting lectures and demonstrations given by Lieutenant Reinartz while on his numerous speaking tours sponsored by RCA. His many friends at RCA and in the amateur fraternity all wish John the best of luck and success in his new work.

HAS 30-WATT FILAMENT



The RCA-808 high-perveance triode is an excellent tube for cw or phone rigs of the medium power class. Amateur net price is only $7.75 at all RCA Power Tube Distributors.

RCA-808 TANTALUM-PLATE TRIODE FB FOR MEDIUM-POWER RIGS

Push-pull 808's Take 400 Watts Input on CW —270 Watts on 'Phone

A large percentage of all amateur transmitters, both 'phone and cw, fall in the medium-power range where the input to the final stage runs somewhere between 100 and 300 watts. The RCA-808 is one of the best triodes available for transmitters in this power class. A single 808 can be operated at a d-c plate input up to 200 watts in cw service, and up to 135 watts in plate-modulated-telephony service.

WINNER!

W3BES, owned by Jerry Mathis of Philadelphia won the 9th A.R.R.L. Sweepstakes with a pair of RCA-809's in his final amplifier! During 40 hours of 1938 contest, W3BES worked 502 stations. His total score was 84,001.25 — a real record.

The 808 has a sturdy, heavy-duty, thoriated-tungsten filament designed to operate at 7.5 volts and 4 amperes, or 30 watts. The ruggedness and generous electron-emitting capability of this filament can be appreciated by comparing it to the 32.5-watt filament used in the old-familiar 203-A and 211 tubes, which have twice the rated plate dissipation of the 808. The tantalum anode of the 808 not only gives the tube a high instantaneous overload capability, but assists in maintaining a high vacuum.

Grid and Plate Connections On Bulb

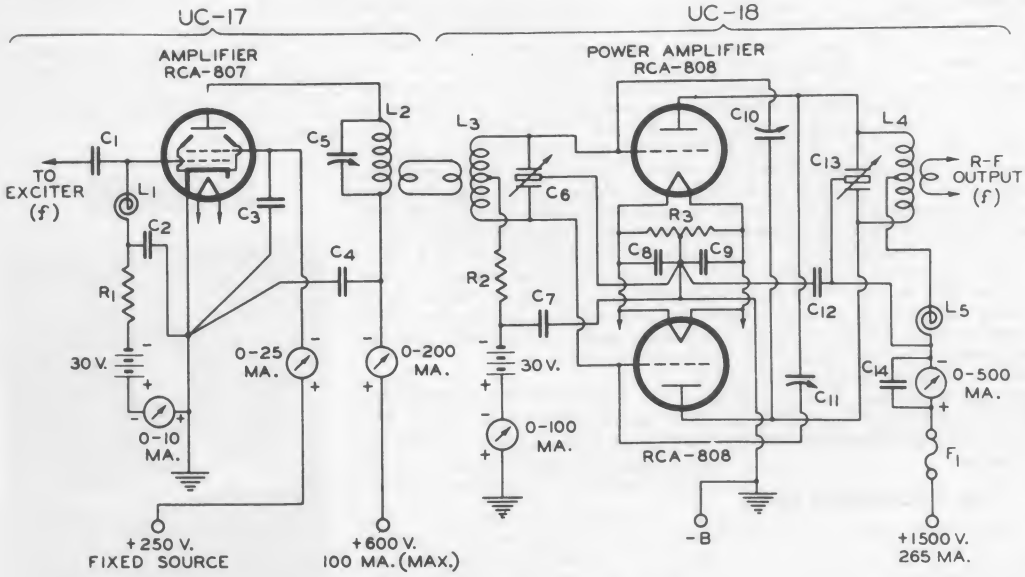
The manner in which the grid and plate leads of the 808 are brought out through the bulb to metal cap terminals helps to insure good insulation and low inter-electrode capacitances. This construction also simplifies the mechanical layout and wiring of a push-pull stage employing a tuned-grid circuit, with link coupling to the driver.

Due to its small, close-spaced electrodes, high perveance, and low grid-plate capacitance, the 808 is particularly suited for efficient operation on the higher frequency amateur bands—40, 20, 10, and 5 meters. It is rated for full input at frequencies up to 30 Mc., and for 75% of maximum input up to 60 Mc. At 10 meters, the 808 operates as stably and is practically as easy to drive as at 20 meters. Many amateurs use a single 807 in the output stage of their exciter units. It so happens that a single 807 operating at 60 watts input will furnish just the right amount of excitation for two 808's in push-pull, even when the latter are plate-modulated—at frequencies up to 30 Mc. Thus, the 807—push-pull 808 arrangement makes a very logical combination.

Push-pull 808's, CW Telegraphy

Circuits UC-17 and UC-18 show such a transmitter, designed for break-in

(*Continued on page 2, column 1*)



CW TELEGRAPH TRANSMITTER

Power Output 300 Watts*

C_1 = 15 to 50 $\mu\mu$f mica
C_3, C_4, C_5 = 0.005 μf mica
C_6 = 2 $\mu\mu$f/meter*
C_6 = 2 $\mu\mu$f/meter/section*
C_7, C_8, C_9, C_{14} = 0.005 μf mica
C_{10}, C_{11} = 2.8 $\mu\mu$f*
C_{12} = 0.002 μf, 5000 v.
C_{13} = 1.1 $\mu\mu$f/meter/section†
R_1 = 7000 ohms, 1 watt
R_2 = 2800 ohms, 25 watts
R_3 = 50 ohms, c.t., wire-wound
L_1 = R-f choke
L_2, L_3, L_4 = Tune to frequency "f"
L_5 = R-f choke, 300 ma.
F_1 = ¾ A. high-voltage fuse
f = Operating frequency
* Approximate.
† Capacitance in actual use.

NOTE: Rotor shaft of C_{13} is at the d-c plate potential; an insulated coupling shaft must be inserted between the rotor shaft and the control dial.

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HAM TIPS from RCA

RCA-808 Triode FB For Medium-Power Amateur Rigs

(*Continued from page 1, column 4*)

cw operation where the crystal oscillator is to be keyed. A 6L6 can be used in the oscillator stage (see circuit UC-1 in Sept. *Ham Tips*), followed by as many frequency doublers as may be required. A 6L6 connected as a high-mu triode, with the screen tied to the control grid, makes a good doubler for this purpose due to the fact that no fixed bias is required (at a plate voltage of 400 volts) to reduce its plate current to a safe value when the key in the oscillator stage is up.

With a 40-meter crystal, the oscillator plate circuit can be used to double to 20 meters so that 20-meter operation can be obtained with the oscillator driving the 807 directly, with no intermediate doublers required. For 10 meters, only one doubler is needed between the oscillator and the 807, assuming again that a 40-meter crystal is used. The 807, in this transmitter arrangement, should usually be operated as a straight amplifier, rather than as a doubler, so as to furnish adequate excitation to the 808's.

Push-pull 808's, Plate-Modulated

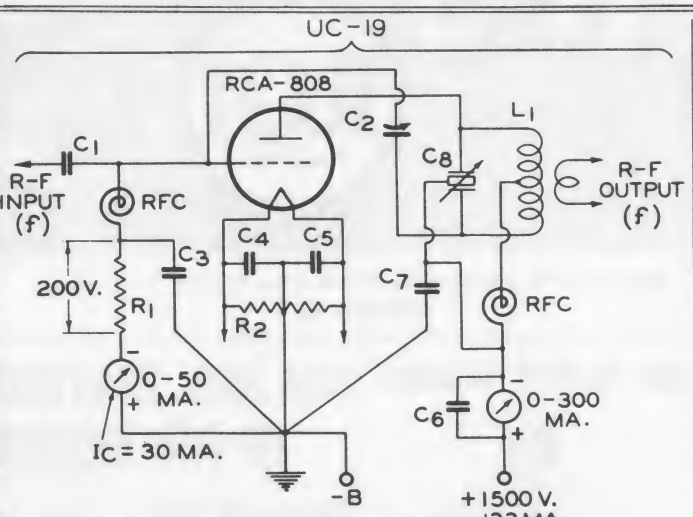
If it is desired to use plate modulation with amplifier stage UC-18, a few changes are necessary. The d-c plate input should not exceed 135 watts per tube, or 270 watts total. With a plate supply of 1250 volts (the maximum rating for plate-modulated telephony), an input of 270 watts is obtained at a d-c plate current of 216 ma. The use of partial fixed bias is not essential; therefore, the 30-volt "C" battery can be omitted. The required grid bias of −225 volts (approx.) can be obtained from grid leak R_2, the value of which should be changed to 3500 ohms. The total d-c grid current should be adjusted to a value somewhere between 60 and 70 ma.

The "modulation impedance" of the push-pull stage is R = E/I, or 1250/0.216 = 5800 ohms (approx.). For 100% sine-wave modulation of the 270-watt input to the r-f stage, a modulator delivering 135 watts of audio power is required. This a-f power can be obtained quite easily from two 808's in class B, which are rated to deliver 190 watts at 1250 volts. This arrangement has the advantage that a single 400-ma., 1250-volt power supply can be used for both the final r-f stage and the class B modulator.

Power Supply Should Have Good Regulation

The power supply, which should have excellent voltage regulation, might well consist of two 866's in a full-wave rectifier circuit, with a 15- or 20-henry choke-input filter. Allowing about 100 volts drop for the rectifier tube and filter, the power transformer should have about 1500 volts RMS each side of the high-voltage center tap. A two-section filter with a 4-*uf* filter condenser before and after a 10-henry smoothing choke will provide a d-c output voltage having less than 0.5% ripple. No filter condenser should be used ahead of the input choke.

For information on a single-ended 808 r-f amplifier, please refer to the discussion of circuit UC-19.



R-F POWER AMPLIFIER

Class C Telegraph Power Output 150 Watts*

C_1 = 0.0005 μf mica
C_2 = 2.8 $\mu\mu$f*
C_3 to C_6 = 0.005 μf mica
C_7 = 0.002 μf mica, 2000 v.
C_8 = 0.6 $\mu\mu$f/meter/section†
R_1 = 6700 ohms, 10 watts
R_2 = 50 ohms, c.t., wire-wound
L_1 = Tune to frequency "f"
RFC = R-f choke
f = Operating frequency
* Approximate.
† Capacitance in actual use.
NOTE: Rotor shaft of C_8 is at the d-c plate potential; an insulated coupling shaft must be inserted between the rotor shaft and the control dial.

QUESTIONS AND ANSWERS

by RCA's Engineering Department

Q. Is it characteristic of the RCA-808 to show color on its plate at very low power inputs? How can one tell when the plate of an 808 is dissipating the rated amount of power?

A. It is perfectly normal for the 808, 806, and other tubes employing tantalum anodes to show a bright, orange-red color at the maximum rated plate dissipation of each type. The plate of an 808 may even show some color due to the heat of the filament alone. At a plate dissipation of 12 to 15 watts, the 808 will definitely begin to show a dull red color. Thus, at the relatively low power input of 45 or 50 watts, in class C r-f amplifier service, some plate color can normally be expected; it is not necessarily a sign that the tube is operating improperly, or inefficiently.

Some amateurs, especially those who are used to tubes with graphite anodes, do not like to see a tube operate with a red plate. However, the plate color of tantalum-anode tubes is actually of value, in many cases, as a warning when the plate circuit is out of resonance and as a rough means of indicating circuit performance.

Easy to determine color

It is a simple matter to determine exactly what plate color an 808 *should* show when it is dissipating its maximum rated power of 50 watts. The grid lead should first be shorted directly to ground, or to the midpoint of the filament circuit, with the r-f excitation removed. The d-c plate input should then be adjusted to 50 watts while the tube is in a non-oscillating condition. The plate voltage and current values can easily be adjusted until their product equals 50 watts, by means of an adjustable resistance in series with the positive high-voltage lead. This method requires both a plate milliammeter and a plate voltmeter. If it is more convenient to use a fixed plate voltage for the test—say 1250 volts—then the d-c plate current can be adjusted to the required 40 ma. by means of a variable d-c grid bias voltage inserted in the grid return lead to the filament. A 22½-volt "C" battery shunted by a 25,000- or a 50,000-ohm potentiometer (receiver type) will provide a simple means of varying the grid bias and plate current. If the test is to be accurate, the plate voltage should always be measured with a good voltmeter. Because the tube is not oscillating, the entire input of 50 watts is dissipated by the plate. Such a test, made as described, will not harm the tube.

Q. Under some conditions of operation, my RCA-807 shows a bluish color in the top part of the bulb. Is this a sign the tube is becoming gassy?

A. A blue glow in the top or near the sides of the glass bulb is usually due to fluorescence caused by stray electrons from the cathode which strike the interior of the bulb. This fluorescence is a natural effect and in no way indicates that the tube is not performing properly. A gassy tube is usually indicated by a blue glow inside the electrode structure, between the cathode and plate.

RCA-808 HAS 150 WATTS OUTPUT ON CW—100 ON 'PHONE

A typical single-ended r-f amplifier employing an RCA-808 is shown in circuit UC-19. Operating at its maximum rated d-c plate input of 200 watts in class C telegraph service, the 808 is capable of delivering an output of about 150 watts. An 807, 809, or 6L6, operating as a frequency doubler, is suitable for the driver stage. The r-f output of the driver should be in the order of 15 to 20 watts (for a discussion of driving-power considerations, refer to page 146 in the TT-3 Transmitting-Tube Manual).

In this circuit, capacity input coupling and grid leak bias are used because of their simplicity and convenience. Keying can be accomplished in the filament center-tap return to ground. If the oscillator stage is to be keyed for break-in operation, a partial fixed bias of about 30 volts (from a battery or other suitable d-c source) should be used, in order to reduce the plate current of the 808 to a low value when the key is up. The remaining 170 volts of grid bias can be obtained from grid leak R_1, the value of which should be reduced to about 5700 ohms.

Single 808, Plate-Modulated

If it is desired to plate-modulate the single-ended 808 amplifier shown in circuit UC-19, the plate-supply voltage should be reduced to 1250 volts. At this plate voltage, the d-c plate current corresponding to the maximum rated d-c power input of 135 watts is 108 ma. A carrier output of slightly over 100 watts can be expected with these operating conditions. The "modulation impedance" of the 808 stage is 1250/0.108, or about 11,600 ohms.

For 100% sine-wave modulation, an audio power of about 68 watts is required. This amount of a-f power can easily be obtained from two 809's in class B.

TELEVISION

RCA Victor Television Attachment TT-5. Has 24 tubes plus 5" Kinescope. Attaches to any radio for sound.

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Form No. 1A570

HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 2—No. 5 CAMDEN, N. J. OCTOBER, 1939

A DOUBLE SCOOP

NEW RCA-811 AND 812 GREATEST TUBE VALUES YET

New Zirconium Coated Anode Gives Astonishing Results

Scene: Meeting room of the local amateur radio club. Two hams, early arrivals, settle themselves comfortably in the second row of chairs, feet propped up on the backs of the chairs in front. The following conversation ensues:

1st Ham: "Say, how's your new 'final' coming along?"

2nd H.: "Not so hot—I had it pretty well under way, but now I've decided to junk the whole works and start all over again—the new tubes, you know."

1st H.: "What? *More* new tubes? What's the dope this time?"

2nd H.: "Haven't you heard? RCA has just announced the new 811 and 812—and they say they're 'head and shoulders' above any other tube now available. Two of 'em in push-pull will take almost 500 watts input, and they cost just a little more than the 809."

1st H.: "Wow! That sounds almost too good to be true."

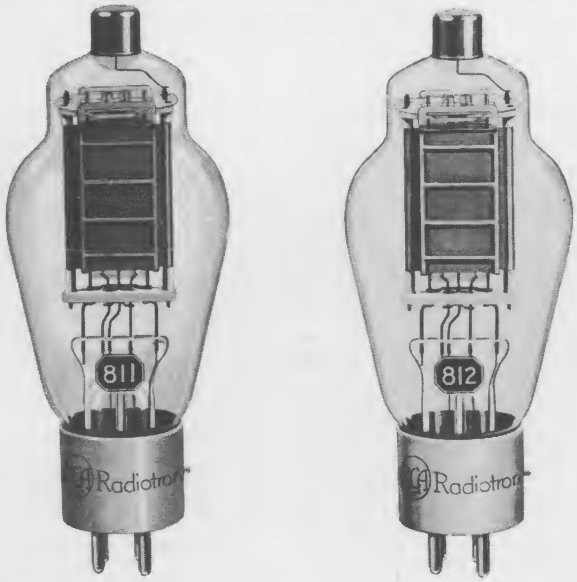
2nd H.: "That's what I thought, at first. But they've worked up some sort of new plate material—'Zirconium coated,' I believe they call it. But here, take this copy of 'Ham Tips'—it tells all about 'em."

A deep silence followed, while Ham No. 1 "boned up" on the new 811 and 812 from the pages of "Ham Tips." Here is what he read:

"The greatest transmitting tube values ever made available to the radio amateur"—that, in the fewest possible words, accurately describes the new 811 and 812, latest additions to the family of RCA high-perveance, easy-to-drive triodes. The RCA power-tube lab has done an outstanding development job on these two new bottles. If, after you have read what follows, you do not agree with this statement, there can be only one conclusion—that the RCA power-tube lab has done a far better job in developing the 811 and 812

(*Continued on page 4, column 1*)

TRULY A MIGHTY PAIR!



RCA-811 RCA-812

At their unbelievably low amateur net price of $3.50 each, the new 811 and 812 represent a new high in transmitting-tube development.

NEW DUAL RATING SYSTEM ANNOUNCED BY RCA

Ratings For Amateur Services Are Greatly Increased

An entirely new system of ratings for air-cooled transmitting tubes has been announced by RCA. Instead of one set of maximum ratings for each tube type, *two* sets of maximum ratings are given. These ratings are designated "Continuous Commercial Service" (CCS) and "Intermittent Commercial & Amateur Service" (ICAS).

The CCS ratings are essentially the same as the former maximum ratings. The ICAS ratings, however, are considerably higher, permit the use of much greater power input, and provide a relatively large increase in useful power output. For example, the a-f power output of two 809's in class B is 100 watts at the old maximum plate-voltage rating of 750 volts. At the new ICAS rating of 1000 volts, the power output is 145 watts—an increase of 45 per cent. In plate-modulated telephony service, the r-f output of the 809 is 38 watts with the CCS ratings and 55 watts with the new ICAS ratings—also an increase of about 45 per cent. Operating data for the 811 and 812, including both CCS and ICAS ratings, are given elsewhere in this issue of HAM TIPS. Similar data have also been prepared for the 802, 804, 806, 807, 809, 810, and 814, as well as for the new 828, and can be obtained on request.

The new system provides transmitting-tube ratings which recognize the diversified design requirements of modern transmitter applications. For example, there are numerous applications where the design factors of *minimum size, light weight, low initial cost,* and *maximum power output* are far more important than extremely long tube life. In such cases, the set designer may very properly decide that a small tube operated with ICAS ratings better meets his requirements than a larger tube operated with CCS ratings.

It is self-evident, of course, that

(*Continued on page 5, column 1*)

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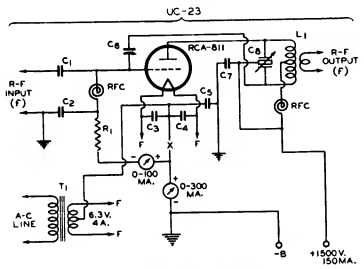
CIRCUIT UC-23 SHOWS SINGLE-ENDED 811 R-F AMPLIFIER FOR CW TELEGRAPHY

A typical 811 single-ended r-f amplifier designed for class C telegraph service is shown in circuit UC-23. Operating at 1500 volts and 150 ma., corresponding to a d-c plate input of 225 watts (ICAS ratings), this amplifier will provide a useful power output of about 170 watts. This output is based on a plate-circuit efficiency of about 75%, which can readily be obtained in a properly designed amplifier stage.

Since the r-f power dissipated by the grid of the 811 is approximately 8 watts, the output of the driver stage should be about 16 watts (using the usual multiplying factor of 2). Some surplus power must be available from the driver in order to provide good regulation of the r-f exciting voltage and to compensate for circuit losses. The required grid bias can be obtained from a 3500-ohm grid leak. The d-c grid current should be about 35 ma., and should never be allowed to exceed 50 ma.

A single 6L6, 6L6-G, or 6V6-G is suitable for the driver stage. Any of these tubes can be connected as a high-mu triode, if desired, with the *screen* tied to the *control grid*. With this convenient arrangement, the oscillator stage can be keyed for "break-in" operation. No *fixed* bias is required for the triode-connected 6L6 or for the 811, due to the fact that their mu is high enough to cause their d-c plate current to drop to a low value when the key is up in the oscillator stage. Grid leak bias is satisfactory. This statement does not apply to the 812, because of its relatively low mu (29). For this reason, the 811 is somewhat preferable to the 812 in cw transmitters where "break-in" operation is contemplated.

The 812 can be used in circuit UC-23 with only two minor changes. The grid leak (R_1) should be changed to 7000 ohms (10 watts), and the neutralizing condenser C_6 may have to be very slightly readjusted. For "break-in" operation with the 812, a partial fixed bias of −45 to −50 volts should be used in conjunction with a grid-leak resistor of 5000 ohms. About the same amount of driving power is required (in cw service).



CW R-F POWER AMPLIFIER

Class C Telegraphy Power Output 170 Watts*

C_1 = 0.0005 μf mica, 1000 V.
C_2, C_3, C_4 = 0.005 μf mica.
C_5, C_7 = 0.002 μf mica, 5000 V.
C_6 = 5.5 μμf,* 6000 V.
C_8 = 0.6 μμf/meter/section,† 2000 V.
R_1 = 3500 ohms, 10 watts.
RFC = R-f choke.
T_1 = Filament transformer, 2000 V. insulation.
L_1 = Tune to frequency "f."
f = Operating frequency.

* Approximate.

† Capacitance in actual use.

NOTE: Rotor shaft of C_8 is at the high d-c plate potential. An insulated coupling shaft must be inserted between the rotor shaft of C_8 and its control dial.

Plate Modulation of Single 812

The 812 is somewhat preferable to the 811 for plate-modulated telephony service. The reason for this is that a tube having a very high mu, like the 811, requires considerably more driving power than a medium-mu tube in order to provide a linear modulation characteristic. This fact, of course, explains the reason for the development of the 812, as otherwise the 811 would meet all design requirements.

Circuit UC-23, using an 812 in place of the 811, can readily be changed for plate-modulated telephony service. The plate supply voltage should be reduced to 1250 volts (maximum ICAS rating) and the full-load plate current to 125 ma. Grid leak R_1 should be changed to 5000 ohms (10-watt size). Under these conditions, and with a driver-stage power output of about 12 watts, a carrier power output of approximately 120 watts can be ob-

(*Continued on page 5, column 4*)

RCA-811

TENTATIVE CHARACTERISTICS and RATINGS

FILAMENT VOLTAGE (A-C or D-C)	6.3	Volts
FILAMENT CURRENT	4	Amperes
AMPLIFICATION FACTOR	160	
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate	5.5	μμf
Grid-Filament	5.5	μμf
Plate-Filament	0.6	μμf
BULB	ST-19	
CAP	Medium Metal	
BASE	Medium 4-Pin "Micanol," Bayonet	

MAXIMUM CCS and ICAS RATINGS with TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service
ICAS = Intermittent Commercial and Amateur Service.

AS A-F Power Amplifier and Modulator—Class B

	(*CCS*)	(*ICAS*)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
MAX.-SIGNAL D-C PLATE CURRENT*	125 *max.*	125 *max.*	Milliamperes
MAX.-SIGNAL PLATE INPUT*	125 *max.*	150 *max.*	Watts
PLATE DISSIPATION*	40 *max.*	50 *max.*	Watts
TYPICAL OPERATION:			
Unless otherwise specified, values are for 2 tubes			
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage#	0	−9	Volts
Peak A-F Grid-to-Grid Voltage	140	160	Volts
Max.-Signal D-C Grid Current	38	38	Milliamperes
Zero-Sig. D-C Plate Current	48	20	Milliamperes
Max.-Sig. D-C Plate Current	200	200	Milliamperes
Load Resistance (Per tube)	3750	4500	Ohms
Effective Load Resistance (Plate-to-Plate)	15000	18000	Ohms
Max.-Sig. Driving Power (Approx.)	3.8	4.2	Watts
Max.-Sig. Power Output (Approx.)	175	225	Watts

As Plate-Modulated R-F Power Amplifier—Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	(*CCS*)	(*ICAS*)	
D-C PLATE VOLTAGE	1000 *max.*	1250 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	105 *max.*	125 *max.*	Milliamperes
D-C GRID CURRENT	50 *max*	50 *max.*	Milliamperes
PLATE INPUT	105 *max.*	155 *max.*	Watts
PLATE DISSIPATION	27 *max.*	40 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	1000	1250	Volts
D-C Grid Voltage:	−100	−125	Volts
From a grid resistor of	2000	2500	Ohms
Peak R-F Grid Voltage	195	230	Volts
D-C Plate Current	105	125	Milliamperes
D-C Grid Current (Approx.)**	50	50	Milliamperes
Driving Power (Approx.)**	9	11	Watts
Power Output (Approx.)	82	120	Watts

As R-F Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation##

	(*CCS*)	(*ICAS*)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	125 *max.*	150 *max.*	Milliamperes
D-C GRID CURRENT	50 *max.*	50 *max.*	Milliamperes
PLATE INPUT	155 *max*	225 *max.*	Watts
PLATE DISSIPATION	40 *max.*	55 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage:			
From a fixed supply of	−87.5	−113	Volts
From a grid resistor of	2500	3500	Ohms
From a cathode resistor of	550	600	Ohms
Peak R-F Grid Voltage	180	225	Volts
D-C Plate Current	125	150	Milliamperes
D-C Grid Current (Approx.)**	35	35	Milliamperes
Driving Power (Approx.)**	7	8	Watts
Power Output (Approx.)	115	170	Watts

* Averaged over any audio-frequency cycle of sine-wave form.

Grid voltages are given for either a-c or d-c filament operation. When a-c is used, the circuit returns are made to the mid-point of the filament circuit. When d-c is used, the returns are made to the negative filament terminal.

** Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should be capable of delivering considerably more than the required driving power.

Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

RCA-812

TENTATIVE CHARACTERISTICS and RATINGS

FILAMENT VOLTAGE (A-C or D-C)	6.3	Volts
FILAMENT CURRENT	4	Amperes
AMPLIFICATION FACTOR	29	
DIRECT INTERELECTRODE CAPACITANCES:		
Grid-Plate	5.3	$\mu\mu f$
Grid-Filament	5.3	$\mu\mu f$
Plate-Filament	0.8	$\mu\mu f$
BULB	ST-19	
CAP	Medium Metal	
BASE	Medium 4-Pin "Micanol," Bayonet	

MAXIMUM RATINGS and TYPICAL OPERATING CONDITIONS

CCS = Continuous Commercial Service.
ICAS = Intermittent Commercial and Amateur Service.

As A-F Power Amplifier and Modulator—Class B

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
MAX.-SIGNAL D-C PLATE CURRENT*	125 *max.*	125 *max.*	Milliamperes
MAX.-SIGNAL PLATE INPUT*	125 *max.*	150 *max.*	Watts
PLATE DISSIPATION*	40 *max.*	50 *max.*	Watts

TYPICAL OPERATION:

Unless otherwise specified, values are for 2 tubes

D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage#	−36	−46	Volts
Peak A-F Grid-to-Grid Voltage	210	232	Volts
Max.-Signal D-C Grid Current	18	25	Milliamperes
Zero-Sig. D-C Plate Current	48	42	Milliamperes
Max.-Sig. D-C Plate Current	200	200	Milliamperes
Load Resistance (Per tube)	3750	4500	Ohms
Effective Load Resistance (Plate-to-Plate)	15000	18000	Ohms
Max.-Sig. Driving Power (Approx.)	4.3	4.7	Watts
Max.-Sig. Power Output (Approx.)	175	225	Watts

As Plate-Modulated R-F Power Amplifier—Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1000 *max.*	1250 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	105 *max.*	125 *max.*	Milliamperes
D-C GRID CURRENT	25 *max.*	25 *max.*	Milliamperes
PLATE INPUT	105 *max.*	155 *max.*	Watts
PLATE DISSIPATION	27 *max.*	40 *max*	Watts

TYPICAL OPERATION:

D-C Plate Voltage	1000	1250	Volts
D-C Grid Voltage:	−100	−125	Volts
From a grid resistor of	4000	5000	Ohms
Peak R-F Grid Voltage	180	245	Volts
D-C Plate Current	105	125	Milliamperes
D-C Grid Current (Approx.)**	25	25	Milliamperes
Driving Power (Approx.)**	4.5	6	Watts
Power Output (Approx.)	82	120	Watts

As R-F Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation##

	(CCS)	(ICAS)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	125 *max.*	150 *max.*	Milliamperes
D-C GRID CURRENT	35 *max.*	35 *max.*	Milliamperes
PLATE INPUT	155 *max.*	225 *max.*	Watts
PLATE DISSIPATION	40 *max.*	55 *max.*	Watts

TYPICAL OPERATION:

D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage:			
From a fixed supply of	−125	−175	Volts
From a grid resistor of	5000	7000	Ohms
From a cathode resistor of	835	1000	Ohms
Peak R-F Grid Voltage	215	285	Volts
D-C Plate Current	125	150	Milliamperes
D-C Grid Current (Approx.)**	25	25	Milliamperes
Driving Power (Approx.)**	5	6.5	Watts
Power Output (Approx.)	116	170	Watts

* Averaged over any audio-frequency cycle of sine-wave form.

Grid voltages are given with respect to the mid-point of filament operated on a-c. If d-c is used, each stated value of grid voltage should be decreased by 3.2 volts and the circuit returns made to the negative end of the filament.

** Subject to wide variations depending on the impedance of the load circuit. High-impedance load circuits require more grid current and driving power to obtain the desired output. Low-impedance circuits need less grid current and driving power, but plate-circuit efficiency is sacrificed. The driving stage should be capable of delivering considerably more than the required driving power.

Modulation essentially negative may be used if the positive peak of the audio-frequency envelope does not exceed 115% of the carrier conditions.

CIRCUIT UC-24 SHOWS PUSH-PULL PLATE-MODULATED 812'S

A typical push-pull 812 r-f amplifier designed for plate-modulated telephony service is shown in circuit UC-24. Operating at 1250 volts and 250 ma. (maximum ICAS ratings), corresponding to a d-c plate input of 312 watts, two 812's are capable of delivering a carrier power of almost ¼ kilowatt. A plate-circuit efficiency of about 75% is assumed, a value which can usually be obtained in practice.

The r-f grid power dissipated by two 812's is about 12 watts, or 6 watts per tube. This means that the actual power output of the r-f driver stage should be in the order of 24 watts. Thus, a single 6L6, or an 807 operating considerably below its maximum ratings, is suitable for the driver stage. An 807 is preferable to a 6L6 because the latter usually requires neutralization in r-f amplifier circuits. In addition, the 807 is capable of delivering the necessary driving power even when it is used as a plate-circuit doubler—a fact which may mean the elimination of an extra doubler stage.

The required grid bias can be obtained from a 2500-ohm, 10-watt grid leak. The d-c grid current should be adjusted to 50 ma., or 25 ma. per tube, the value which is the maximum rating. In order to protect the final amplifier against accidental loss of bias (due to failure of the grid excitation) or accidental plate-circuit detuning, a d-c overload relay set to operate at 375 ma. should be employed. The holding coil of the relay can conveniently be placed between the −B lead and ground, provided the 812's are the only tubes operated from the 1250-volt plate supply. Otherwise, the relay coil should be placed between the 500-ma. plate meter and ground (see circuit UC-24); in this position, the relay should be by-passed by an electrolytic condenser large enough for low audio frequencies.

Connected as shown, the plate meter will read only the d-c plate current, and not the *sum* of plate current and grid current. Moreover, the plate meter is at ground potential and does not represent a high-voltage hazard such as it does when it is placed in the +B lead.

To modulate the 812's 100%, an a-f power of about 160 watts is required. A pair of 811's operating in class B at a plate voltage of 1250 volts (zero bias) will deliver 175 watts, and are, therefore, well suited for the modulator stage. A pair of 6L6's in class AB_1 are recommended for the audio driver stage in an inverse feedback circuit (see the circuit and curves of Fig. 1). An a-f driving voltage of only 12 volts RMS per grid will drive the 6L6's to the point required for full output from the class B 811's. A pair of 809's in class B, with their new ICAS ratings, will deliver 145 watts of a-f power. They will, therefore, also do a very good job of modulating two 812's.

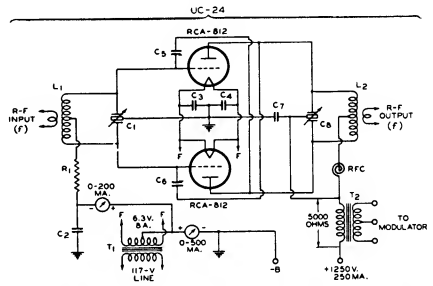


PLATE-MODULATED R-F POWER AMPLIFIER

Class C Telephony Power Output 240 Watts*

C_1 = 1.5 $\mu\mu f$/meter/section.*
C_2, C_3, C_4 = 0.005 μf mica.
C_5, C_6 = 5.3 $\mu\mu f$,* 6000 V.
C_7 = 0.002 μf, 5000 V.
C_8 = 1.2 $\mu\mu f$/meter/section,† 3500 V.
R_1 = 2500 ohms, 10 watts.
RFC = R-f choke, 250 ma.
T_1 = Filament transformer.
T_2 = Modulation transformer, 155 watts.
L_1, L_2 = Tune to frequency "f."
f = Operating frequency.
* Approximate.
† Capacitance in actual use.

NOTE: Rotor shaft of C_8 is at the high d-c plate potential. An insulated coupling shaft must be inserted between the rotor shaft of C_8 and its control dial.

CW Telegraph Operation of 812's

If the 812's in circuit UC-24 are to be used for cw service, the plate voltage may be increased to 1500 volts and the total plate current to 300 ma. The grid leak (R_1) should be increased to 3500 ohms (15- or 20-watt size). The grid current should be 50 ma., as before. Slightly more driving power is required, due to the higher bias and higher plate voltage. The

(*Continued on page 5, column 3*)

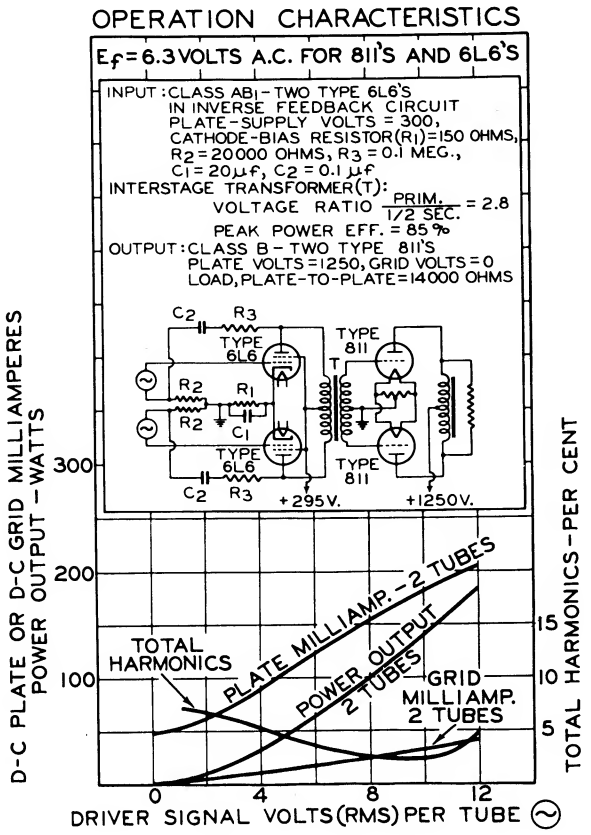


Figure 1

New RCA-811 and 812 Greatest Tube Values Yet

(*Continued from page 1, column 1*)

than the editors of "Ham Tips" have done in describing them. To avoid this possibility, the editors are going to digress from the 811 and 812 for just a moment.

Most of you, when you are thinking of building a new rig or of rebuilding an old one, generally decide first how much *power input* you would like to use. The state of the old pocketbook very often influences this decision to a large degree. You will, therefore, other factors being equal, choose a tube (or tubes) which will take the *largest power input* compatible with the total cost involved. The tube chosen must, in other words, have a high "figure of merit" expressed in terms of *power input watts* per *unit cost* ($W_{in}/\$$). Because this term completely ignores *tube life performance*, the true, intrinsic worth of a tube is better expressed by a term which includes life; namely, *power input watt-hours* per unit cost. From a practical viewpoint, however, the first term is more convenient and you must necessarily depend on the integrity and reputation of the tube manufacturer to insure that you will obtain reasonable tube life under the rated operating conditions which he recommends.

Another useful figure of merit is the *power sensitivity* of a tube, which is a measure of how easy the tube is to drive. This factor, for convenience, can be expressed as the ratio of useful class C power output to the required grid driving power.

In order to show vividly the outstanding performance of the new 811 and 812, we have prepared the table shown below. Tubes A, B, C, and D represent four competitive tubes which were chosen because they had relatively *high* figures of merit. The data given in the table are interesting as well as informative.

Tube Type	*Initial Cost Factor* $W_{in}/\$$*	*Power Sensitivity Factor* W_{out}/W_g*
RCA-812	64	26
RCA-811	64	21
A	40	22
B	37	23
C	33	17
D	32	23

* Approximate.

The significance of the high $W_{in}/\$$ factor for the 811 and 812 can best be appreciated if you will stop to think that it is now possible to construct a final amplifier having a rated input of almost ½ kilowatt, using two tubes whose total cost is only $7.00!

Now for some detailed information. The RCA-811 and RCA-812 are husky triodes with a maximum plate dissipation of 55 watts for class C telegraph service. Operating at 1500 volts (ICAS rating), two tubes of either type can be used in a push-pull circuit with a d-c plate input of *450 watts*, and with the unusually low driving-power requirement of only *13 to 16 watts*. The 811 and 812 may be operated at maximum ratings in r-f services at frequencies up to 60 Mc. and at reduced ratings up to 100 Mc.

The 811 is a zero-bias, high-mu class B modulator, as well as an excellent r-f tube. Two 811's in class B provide 225 watts of a-f power, which will do a good job of modulating a ½ kw. 'phone transmitter. A typical class B modulator stage using two 811's driven by two 6L6's, with inverse feedback, is shown in Fig. 1. Operating characteristics are shown in the curves of Figs. 1 and 2. Because of its high perveance and high mu (160), the 811 makes an efficient plate-circuit frequency doubler.

The 812, especially designed for r-f services, has a medium mu of 29. It requires slightly less driving power than the 811 in cw telegraph service. In plate-modulated telephony service, however, the 812 requires much less driving power than the 811 (about one-half).

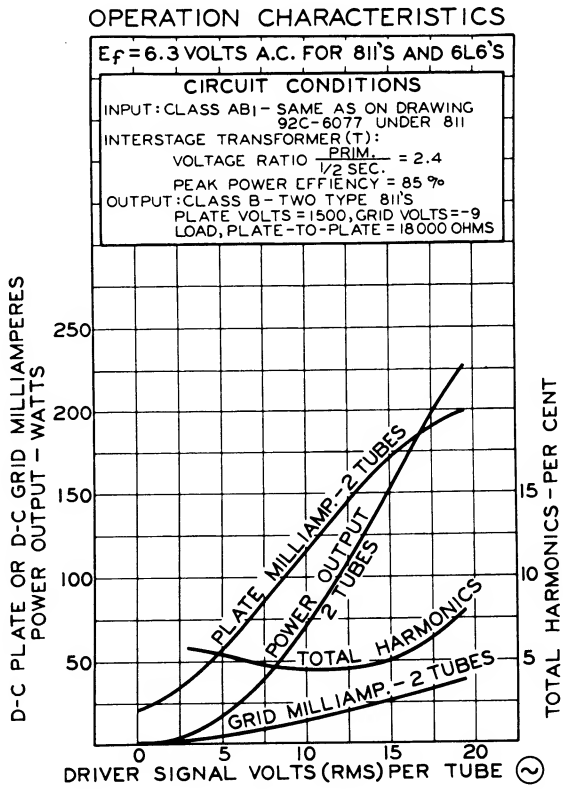
Both the 811 and 812 are equipped with the new low-loss "Micanol" base, which has excellent insulating qualities at high radio frequencies together with low moisture-absorption characteristics. The plate lead is brought out to a metal top cap to provide high insulation.

The remarkable performance characteristics of both tubes are due in large measure to the use of a new type of anode. The plate, which is Zirconium-coated, has unusually high heat-dissipating qualities and in addition functions as an exceptionally effective "getter." Thus, any gas produced by overloads is cleaned up by the plate coating. As a result of this "getter" action of the Zirconium-coated anode, the 811 and 812 are capable of withstanding relatively heavy temporary overloads without damage to their filament emission. This is one virtue in a transmitting tube which most amateurs fully appreciate.

In an actual operating test, two 811's were used in a push-pull circuit on 14 megacycles under heavy overload conditions. The plate-tank condenser was repeatedly de-tuned from resonance so that the plate current and plate dissipation rose to excessive values. This intentional abuse was continued until finally *large holes were melted in the plates of both tubes.* The amplifier was then adjusted to rated operating conditions (with maximum ICAS values of plate voltage and current) and was found to operate quite normally.

Destructive overload tests have brought out one peculiarity of a Zirconium-coated anode. When a plate dissipation of about 150 to 160 watts is reached, the high plate

(*Continued on page 6, column 1*)



New Dual Rating System Announced by RCA

(*Continued from page 1, column 4*)

the harder a tube is worked the shorter will be its useful life. Although no rule can be set up which will accurately predict the life performance of an individual tube under specified operating conditions, it is practical to make an estimate of tube life on the basis of average results from a large number of tubes. In average amateur service, a tube operated at the higher ratings can normally be expected to give about 50 per cent of the life obtainable with CCS ratings.

It has been estimated that an active amateur does not have his carrier on the air more than 300 hours per year. Therefore, a tube lasting 1000 to 1500 hours when used with CCS ratings would give him at least 3½ to 5 years of service. The amateur, because he is usually most interested in *low initial cost* and *maximum power output*, may consequently decide that the ICAS ratings are better suited for his purpose.

The engineer designing a broadcast transmitter has quite a different problem. A broadcast station may operate tubes on an average of 18 hours a day. Tube failures are expensive both in themselves and in advertising revenue lost because of interrupted programs. Consequently, since *reliability* is his main concern, he should operate tubes at the CCS ratings, or perhaps even lower. Only in this way can he obtain the long tube life required for continuous commercial services.

In airplane transmitters, tubes may be operated only a few minutes a day. In addition, mechanical failure of tubes may occur prematurely, due to the severe vibration and shock to which they are frequently subjected. For these reasons, operation of tubes at ICAS ratings, especially where maximum power output for a minimum size and weight are essential, should be considered. On the other hand, there are installations where it is imperative that the tubes be ready for operation at all times, because failures at the wrong moment may mean damage to an expensive airplane or even loss of human life. The choice of tube-operating conditions for any service must, therefore, be based on a careful consideration of all factors.

In view of the fact that the ICAS ratings are considerably higher than the former maximum ratings, an explanation of the basis on which these new ratings are established is desirable. The old method of rating transmitting tubes has been based on the assumption that tubes would always be used under the most severe operating conditions possible for each class of service. Although it was recognized that this method was not representative of actual operating conditions, it did provide a very large factor of safety. In recent years, rapid progress in tube design, tube manufacture, transmitter design, and operating technique has made it practical to refine the method of rating transmitting tubes so that it more closely represents actual operating requirements.

For example, in class C telegraph service, the old ratings were set up on the basis of continuous, key-down operation. In practice, however, all class C stages which are keyed are not under load when the key is up, as it is during spacing intervals. The average load on the tube is, of course, much less than it is under steady, key-down conditions.

In class C plate-modulated telephony service, the old ratings were based on steady, 100 per cent, sine-wave modulation. Under this condition, the total plate input (d.c. and a.c.) is 1.5 times the unmodulated d-c plate input. In practice, a broadcast transmitter (for example) modulates its carrier on the average only 25 to 30 per cent. Under these conditions, the average plate power input is only 5 per cent higher than the unmodulated d-c plate input.

Similarly, the old class B a-f amplifier ratings were based on steady, full-signal operating conditions with a sine-wave signal. Actually, the average signal is much smaller than the maximum value and the average d-c plate current and power input varies continuously between no-signal and full-signal values. In addition, it is well known that speech signals place a much lighter load on the class B amplifier than signals having sinusoidal waveform.

In class B r-f amplifier service, the old ratings were based on *carrier* conditions where the carrier output represents ⅓ of the d-c plate input and the other ⅔'s is dissipated by the plate. At 100 per cent modulation, however, the efficiency of the amplifier increases to approximately 50 per cent, so that the plate dissipation is reduced about 25 per cent. However, because the average decrease in plate dissipation is rather small, the ICAS ratings for this class of service have to be more conservative than for the other services.

It is apparent from the foregoing considerations that increased transmitting-tube ratings are practical for many applications. The new ICAS ratings, together with the CCS ratings, make it possible for the radio amateur and the radio engineer to choose the operating conditions best suited for the job at hand. Undoubtedly, the introduction by RCA of this new system of dual ratings for transmitting tubes represents a most important contribution to the art.

Because of the interest RCA's new Dual Rating System is certain to excite, especially among radio amateurs, a 16-page booklet has been prepared giving ICAS maximum ratings and typical operating conditions for the tube types: 802, 804, 806, 807, 809, 810 and 814. This booklet may be obtained on request from RCA Manufacturing Co., Inc., Commercial Engineering Section, Harrison, N. J. Abbreviated data on the types listed above are shown on page 6, column 2; both CCS and ICAS values are given for purposes of comparison.

Circuit UC-24 Shows Push-Pull Plate-Modulated 812's

(*Continued from page 3, column 4*)

power output can be increased to 340 watts from the 240 watts obtainable in plate-modulated telephony service.

If 100% grid-leak bias is used, as described above, the 812's can be keyed in the filament-to-ground circuit. An extra filament by-pass condenser is needed, and the filament circuit (transformer and by-pass condensers) should be changed to the arrangement shown in circuit UC-23. The filament-circuit connections shown in circuit UC-24 are for 'phone work only.

Where the *oscillator* or other *preceding* stage is to be keyed, as for "break-in" operation, a partial fixed bias of −45 to −50 volts should be employed in conjunction with a 2500-ohm, 10-watt grid leak. With this amount of fixed or battery bias, the d-c plate current of the 812's will remain near cut-off when the key is up (that is, when the grid excitation is removed). With grid-leak bias only, the d-c plate current would rise to an excessive value as is always the case with medium-mu tubes.

In cw service, the neutralizing condensers (C_5 and C_6)shown in circuit UC-24 can have a peak voltage rating of only 3000 volts, instead of the 6000 volts needed for telephony service. Similarly, the voltage rating of C_8 can be reduced to 2000 volts.

Circuit UC-24 with Push-Pull 811's

Two 811's can be substituted for the two 812's in circuit UC-24 if two changes are made. In plate-modulated telephony service, grid leak R_1 should be changed to 1250 ohms (25-watt size). In addition, the driver-stage power output must be increased to about 45 watts.

For push-pull 811's in cw telegraph service, grid leak R_1 should be changed to about 1600 ohms (10-watt size). The driver-stage power output for this service should be approximately 32 watts. Due to the extremely high mu of the 811's, they can be used for "break-in" operation (oscillator-stage keying) with grid-leak bias only; partial fixed bias is not necessary. When grid excitation is removed from the 811's, their plate current drops to a very low value. This characteristic is an advantage not possessed by medium-mu tubes, such as the 812. If, however, "center-tap" keying of the push-pull final amplifier stage is employed, there is little difference on which to base a choice between the 811 and the 812. With center-tap keying, the connections of the filament transformer and by-pass condensers should be changed to the arrangement shown in circuit UC-23.

A transmitter using push-pull 811's or 812's is capable of offering real competition to one-kw stations on any of the popular amateur bands. If a good two- or three-element beam antenna is used on the higher-frequency bands, a rig of this type will put through a strong signal with excellent consistency.

Circuit UC-23 Shows Single-Ended 811 R-F Amplifier For CW Telegraphy

(*Continued from page 2, column 2*)

tained from a well-designed amplifier stage.

To modulate the 812, operating with an input of about 155 watts, an a-f power of approximately 80 watts is required. This can economically be obtained from a pair of 809's in class B, driven by push-pull 2A3's in class A. The modulation resistance presented by the 812 across the secondary of the modulation transformer is 1250/0.125, or 10000 ohms.

The plate-tank condenser (C_8) shown in circuit UC-23 is rated for 2000 volts peak. For plate modulation, C_8 should be rated for twice this value, or 4000 volts peak. A split-stator condenser having an air gap of 0.07" (not less) between adjacent rotor and stator plates is adequate. If the frame and rotor of C_8 were not tied to +B, an air gap of 0.140" would be necessary. The 6000-volt peak rating shown for neutralizing condenser C_6 is adequate for either cw or 'phone. A 3000-volt rating would do for cw alone.

A carrier power of 170 watts (cw) or 120 watts ('phone) is capable of giving excellent results in the amateur high-frequency bands. At a price of $3.50 for the 811 or 812, such a transmitter is hard to beat on a basis of performance versus cost.

HAMS PLEASE NOTE!

WIN $5.00!

Does your transmitter use RCA tubes throughout?

If so, send us a photograph and a brief description of it. Photos of final amplifier stages are also suitable. We should like to publish one or more such photos in each issue of HAM TIPS. Those published win $5.00 cash. "Commercial type" rigs are *not* given preference—what have you?

(This offer good in Western Hemisphere, Hawaii, and the Philippine Islands.)

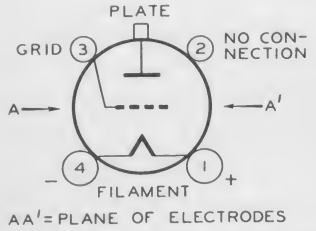
New RCA-811 and 812 Greatest Tube Values Yet

(*Continued from page 4, column 4*)

temperature causes the plate to *alloy* with the Zirconium coating. This action produces an oval-shaped shiny spot in the middle of the plate. The bright spot, once formed, remains permanently, but does not necessarily affect the operation or efficiency of the tube in subsequent normal operation. If the excessive overload is allowed to persist long enough, a silvery coating may form on the interior surface of the glass bulb.

In order to avoid excessive plate overloads, with the attendant "spotting" of the plate and darkening of the bulb, the amateur need only observe the usual precaution of using either a suitable d-c overload relay or a protective resistor in series with the plate supply lead. A 100-watt, 10000-ohm resistor will protect an 811 or an 812 during "tuning up" operations when a new circuit is being adjusted for the first time (before the correct setting of the plate condenser, for resonance, is determined). The resistor should, of course, be shorted or taken out of the circuit during normal operation of the transmitter. A d-c overload relay is preferable to a protective resistor, because a relay can be left in the circuit at *all times* and offers permanent protection. The relay should be set to open the primary circuit of the high-voltage supply when the d-c plate current reaches a value 50% greater than normal—that is, a value of 225 ma. for a single 811 or 812.

Many radio amateurs may feel that the use of such protective devices is not necessary for home-built transmitters. It should be remembered, however, that a protective device will not only protect the r-f amplifier tubes but may also prevent the destruction of meters, power transformers, rectifier tubes, and other circuit components. Just *one* heavy overload removed in time may represent a saving many times the cost of an inexpensive overload relay. But here, we're digressing again from our original purpose. That was, if you remember, to tell you that the new RCA-811 and RCA-812 are a mighty swell pair of tubes!



AA' = PLANE OF ELECTRODES

Top View of Socket Connections for the New RCA-811 and 812

THUMB-NAIL DATA SHOWING CCS AND ICAS COMPARISONS

802—R-F AMPLIFIER PENTODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	500	600 V.
Max. plate current	60	60 Ma.
Max. plate dissipation	10	13 W.
Max. plate input	25	33 W.
Grid driving power	0.25	0.3 W.
Carrier power output	16	23 W.

$3.50 Amateur Net.

804—R-F AMPLIFIER PENTODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	1250	1500 V.
Max. plate current	95	100 Ma.
Max. plate dissipation	40	50 W.
Max. plate input	120	150 W.
Grid driving power	0.95	1.95 W.
Carrier power output	80	110 W.

$15.00 Amateur Net.

806—TANTALUM-PLATE TRIODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	3000	3300 V.
Max. plate current	200	300 Ma.
Max. plate dissipation	150	225 W.
Max. plate input	600	1000 W.
Grid driving power	20	34 W.
Carrier power output	450	780 W.

$22.00 Amateur Net.

807—BEAM POWER TETRODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	600	750 V.
Max. plate current	100	100 Ma.
Max. plate dissipation	25	30 W.
Max. plate input	60	75 W.
Grid driving power	0.22	0.22 W.
Carrier power output	37.5	50 W.

$3.50 Amateur Net.

809—HIGH-MU TRIODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	750	1000 V.
Max. plate current	100	100 Ma.
Max. plate dissipation	25	30 W.
Max. plate input	75	100 W.
Grid driving power	2.5	3.8 W.
Carrier power output	55	75 W.

$2.50 Amateur Net.

810—HIGH-MU TRIODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	2000	2250 V.
Max. plate current	250	275 Ma.
Max. plate dissipation	125	150 W.
Max. plate input	500	620 W.
Grid driving power	12	12 W.
Carrier power output	375	475 W.

$13.50 Amateur Net.

814—BEAM POWER TETRODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	1250	1500 V.
Max. plate current	150	150 Ma.
Max. plate dissipation	50	65 W.
Max. plate input	180	225 W.
Grid driving power	1.5	1.5 W
Carrier power output	130	160 W.

$17.50 Amateur Net.

828—POWER AMPLIFIER PENTODE

Class C Telegraphy	*CCS*	*ICAS*
Max. plate voltage	1250	1500 V.
Max. plate current	160	180 Ma.
Max. plate dissipation	70	80 W.
Max. plate input	200	270 W.
Grid driving power	2.1	2.2 W.
Carrier power output	150	200 W.

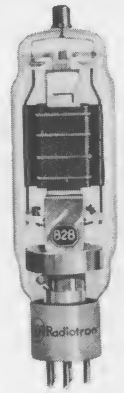
$17.50 Amateur Net.

NEW RCA-828 BEAM POWER TUBE DESIGNED FOR A-F SERVICE — ALSO EXCELLENT FOR R-F APPLICATIONS

Tow 828's in AB_1 deliver 300 watts of a-f power with only 1% distortion!

RCA-828 is a new multi-electrode transmitting tube with a maximum plate dissipation rating of 80 watts (ICAS) for class AB_1 and class C telegraph services. The 828 contains a suppressor and has beam power features. This tube is designed particularly for use as a class AB_1 modulator and audio-frequency power amplifier; it is also well-suited for use in radio-frequency applications as an r-f power amplifier, frequency multiplier, oscillator, and grid- or plate-modulated amplifier. Two 828's in class AB_1 service (CCS ratings) are capable of delivering 300 watts of audio power with only 1% distortion! Because of its high power sensitivity, RCA-828 can be operated in r-f services to give full power output with very little driving power and, consequently, with a minimum number of driver stages. Neutralization is unnecessary in adequately shielded circuits. The 828 is ideal for use in transmitters where quick band change without neutralizing adjustments is required. The tube may be operated at maximum ratings at frequencies as high as 30 Mc. and at reduced ratings up to 75 Mc. RCA-828 is equipped with the new "MICANOL" base which has excellent insulating qualities at high radio frequencies together with low moisture-absorption characteristics. The plate connection of the tube is brought out through a separate seal at the top of the bulb to provide high insulation.

In class AB_1 audio service, the 828 is operated so that no grid current flows during any part of the input signal cycle. Fixed bias should be employed. Cathode bias is unsuitable because, in a push-pull class AB_1 circuit, two 828's have a d-c plate-current variation of from 50 to well over 200 ma. Obviously, such a plate-current swing would cause an excessive bias shift if self-bias were used. Since no grid current is drawn, a power driver stage is not required. A push-pull voltage amplifier using small receiving tubes such as the 6J7 is suitable for the driver stage. At the maximum ICAS plate-voltage rating of 2000 volts, two 828's are capable of delivering up to 385 watts of audio power with low distortion.



RCA 828

This new transmitting pentode is designed especially for class AB_1 service. It is also an excellent r-f amplifier. Amateur net price, $17.50.

In r-f amplifier service (class C telegraphy), an 828 will deliver an output of approximately 200 watts with a d-c plate-voltage of 1500 volts (maximum ICAS rating for r-f service). The power output of the driver stage should be about 5 watts. Thus, almost any small a-f or r-f power amplifier tube is suitable for the driver stage. A 6V6-G or a 6L6 as a "Tritet" crystal oscillator will drive an 828 very nicely, even if frequency doubling is used in the oscillator plate circuit.

In many respects, the 828 is similar to the RCA-804. Although the 828 has a suppressor grid, this new tube is not recommended for suppressor-modulated telephony service. The suppressor - voltage / power - output characteristic is not linear when the suppressor is operated with a negative bias.

A subsequent issue of HAM TIPS will describe the 828 at greater length; circuits for both a-f and r-f applications will be shown. A technical bulletin on the 828 is now available and may be obtained on request.

BE SURE TO SEE YOUR RCA POWER-TUBE DISTRIBUTOR NEXT MONTH FOR YOUR COPY OF NOVEMBER "HAM TIPS". IT WILL INCLUDE A CONSTRUCTIONAL ARTICLE ON A PUSH-PULL 811 AMPLIFIER, WITH AN 807 DRIVER STAGE ON THE SAME CHASSIS.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation

Printed in U.S.A.

Form 1G1290

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VOL. 2 — No. 6 CAMDEN, N. J. NOVEMBER, 1939

R-F TUBE COST OF 450-WATT RIG ONLY $11.50

NEW RCA DUAL RATINGS MEET WIDE APPROVAL

Permit Increases of Power in Many Rigs

Judging by the comments we have already received regarding our new Dual Rating System, both directly and through our correspondence, it is evident that radio amateurs and many other users of RCA Transmitting Tubes welcome the new System with open arms. Unquestionably, the CCS and ICAS ratings for many of the most popular air-cooled transmitting tubes offer a high degree of flexibility in transmitter design which is almost equivalent to the introduction of many new tube types having

(*Continued on page 4, column 3*)

MINIATURE!

Four new miniature tubes that provide a complete complement for the design of compact, lightweight, portable equipment have just been announced by RCA. They are only two inches in length by three-quarters of an inch in diameter and give highly efficient operation from a 45-volt "B" supply.

PICTURES?

We are still paying $5.00 each for good photos of 100% RCA tubed transmitters. Final amplifier stages are O.K. Give us a brief description with important details. What have you?

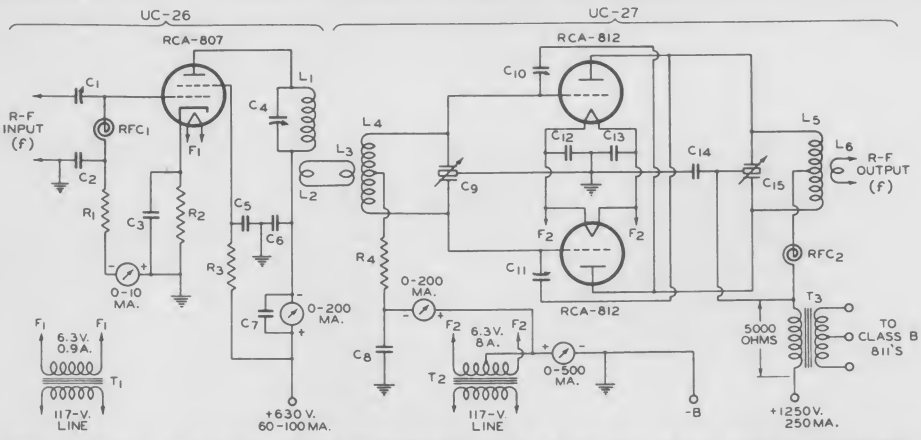
(This offer good in Western Hemisphere, Hawaii, and the Philippine Islands.)

RCA-812's DRIVEN BY RCA-807 MAKE EXCELLENT COMBINATION

Has 240 Watts Output on 'Phone and 340 Watts Output on CW

A transmitter employing a pair of the new RCA-812's or RCA-811's driven by a single RCA-807 may not be the last word in ham rigs, but it is a rig which you will find extremely hard to beat on a basis of tube cost versus performance. The final amplifier chassis of such a transmitter, including the 807 driver stage, is shown in the accompanying photographs and circuits.

This rig, using only three $3.50 tubes, plus a $1.00 "Tritet" crystal oscillator tube (RCA-6V6-G) for the exciter, has a total tube cost for the r-f section of only $11.50. Since push-pull 812's, operating at the moderate plate voltage of 1500 volts, will take an input of 450 watts (class C telegraphy), the cost of the r-f tubes is unbelievably low. Expressed in terms of *power amplifier watts input per dollar of total r-f tube cost*, it is 450/11.50 or 39.2 watts input per dollar. Until the recent announcement of the new RCA-811 and RCA-812, this figure was excellent *even for a single r-f amplifier stage!* Facts and figures speak for themselves as regards the extreme economy of the push-pull 812 rig now to be described.



PUSH-PULL R-F POWER AMPLIFIER 812's‡ WITH 807 BEAM POWER DRIVER STAGE

Class C Telephony Power Output 240 Watts* **Class C Telegraphy Power Output 340 Watts†***

C_1 = 10-70 μμf mica trimmer (ceramic-base type).
C_2, C_3, C_5, C_6, C_7, C_8, C_{12}, C_{13} = 0.005 μf mica.
C_4 = 165 μμf, 0.05″ air gap (Cardwell Midway Type MO165BS).
C_9 = 260 μμf/section, 0.031″ air gap (Cardwell Dual Midway Type MR260BD).
C_{10}, C_{11} = 4-7 μμf, 0.140″ air gap (Cardwell Type ZS7SS).
C_{14} = 0.002 μf mica, 5000 volts (Sangamo).
C_{15} = 100 μμf/section, 0.070″ air gap (Cardwell Dual Midway Type MT100GD).
R_1 = 10,000 ohms, 1 watt.
R_2 = 300 ohms, 10 watts.
R_3 = 40,000 ohms, 10 watts.
R_4 = 2500 ohms, 10 watts (photo shows 5000-ohm, 25-watt adjustable resistor).
RFC_1, RFC_2 = 2½ millihenry r-f choke** (National Type R-100).
L_1 = 9 turns 3/16″ copper tubing, 2″ inside diameter, 4½″ long (20 meters).
L_2, L_3 = 2-turn coupling link, #18 insulated wire (or larger).
L_4 = 14 turns #12 solid enamel, 1 3/8″ inside diameter, 1½″ long, mounted on 5-pin tube base (20 meters).
L_5 = 12 turns 3/16″ copper tubing, 2½″ inside diameter, 4¼″ long (20 meters).
L_6 = 2-turn output link, #12 solid wire, around center of L_5 (see text) and insulated for 3000 volts.
T_1 = 6.3-volt, 1-ampere filament transformer (Thordarson T19F80).
T_2 = 6.3-volt, 10-ampere filament transformer (Thordarson T19F99).
T_3 = Modulation transformer, 150-175 watts; primary, plate-to-plate, 15,000 ohms; secondary, 5000 ohms. (Not shown.)

‡ Or 811's—see text.
* Approximate.
† At 1500 plate volts and 300 ma. plate current.
** More inductance may be desirable at the lower frequencies.
NOTE: Rotor shaft of C_{15} is at high d-c plate potential. An insulated coupling shaft must be inserted between rotor shaft of C_{15} and its control dial. Same applies to C_4.

Uses Standard Parts

The various circuit components which are mentioned by manufacturer's trade name are the parts which were actually used in the construction of this transmitter. In many cases, equivalent parts of other manufacture can be substituted if desired.

The 807 driver and the push-pull 812's are mounted on an "Electralloy" chassis 10″ x 17″ x 3″, a size suitable for relay rack mounting. The spacing between the various parts on top of the chassis is not particularly critical and can be seen in the top-view photograph. The split-stator

(*Continued on page 2, column 1*)

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Tube Cost of 450-Watt Rig Only $11.50

(*Continued from page 1, column 4*)

grid condenser C_9 is mounted in the exact center (lengthwise) of the chassis. The other parts are then placed on the chassis so as to provide short grid and plate leads. The 807 plate tank L_7C_4 is at the left, L_4C_9 is in the center, and L_5C_{15} is at the right. The neutralizing condensers C_{10} and C_{11} are mounted, by means of standard brackets supplied with the Cardwell AFU "100-watt" foundation unit, underneath the split-stator plate condenser C_{15}. This latter condenser, also a part of the AFU foundation unit, includes two type "M" base-mounting brackets which were shifted over to mount the grid condenser (C_9), type "MR260BD." The plate condenser, the *frame* of which *can not be grounded* to the chassis because it is tied to the +B lead (see circuit UC-27), is mounted on two sturdy metal-base ceramic pillars ½ inch in diameter and 1¼ inches high. Standard right-angle brackets fasten the condenser frame to the ceramic insulators. If the +B connection to the rotor frame were omitted, C_{15} would have to have twice as much air gap between adjacent plates and would be much more bulky *and* expensive.

The two type "BW" yoke brackets supplied with the AFU foundation unit are not needed, because the 812 plate coils are mounted on home-made "Mycalex" jack-and-plug strips measuring ¾" x 5½" x ¼". An outline drawing of these coil mountings is shown in Fig. 1.

The 807 plate-coil mounting is similar to that used in the final stage, except for the location and number of the plugs and jacks. Although the material used for the coil-mounting strips in this stage was not "Mycalex," it is preferable to use Mycalex (or other suitable low-loss material), at least for the jack strip and for the 10-meter-coil plug strip. Fig. 2 shows an outline drawing of the 807 coil mountings.

Individual Coupling Adjustments Easily Made

The aluminum brackets mounting the jack strip to condenser C_4 are designed to fit the *front* frame screw and the *rear* stator terminal of the condenser. The two plate-coil jacks go through both the insulating strip and the two mounting brackets, the latter forming the leads from coil to condenser. The two inner jacks are for the link circuit, the 2-turn link being an integral part of each plate coil. This arrangement allows individual coupling adjustments to be made once and then left alone, for each band. The tight coupling of the link as shown in the photograph was adequate to drive plate-modulated push-pull 811's, and overdrives two 812's. For the latter tubes, the link should be bent outward to loosen the coupling. As an incidental point, the neutralizing condensers did not have to be readjusted whether 811's or 812's were "plugged in" the final stage. The only change needed was in the grid excitation and in the value of grid leak R_4.

Clean, simple construction is a feature of this power amplifier using a pair of RCA-812's driven by an RCA-807. Maximum output is 340 Watts CW.

Design data for the 20-meter coils (the ones shown in the photo) are given in the legend beneath circuit diagrams UC-26 and UC-27. Home-made coils are used because they readily permit the desired LC ratio to be obtained for each band. This point deserves an explanation. The 812 stage shown in circuit UC-27, being designed for plate-modulated telephony (changes for cw operation are covered further along), operates with the ICAS ratings of 1250 volts and 250 ma. Applying the ratio E_b/I_b (1250/250) to the capacitance chart on page 151 of the RCA TT-3 Manual, we find that a plate tuning capacitance (for a single-ended circuit) of 25 $\mu\mu$f is indicated for a tank-circuit "Q" of 12, at 10 meters. For a *split-tank* circuit, this value becomes ½ of 25, or 12.5 $\mu\mu$f per condenser section for the 10-meter band. This is 12.5/10, or 1.25 $\mu\mu$f per meter per section. At 20 meters, therefore, the inductance of L_5 should be such that it resonates to the operating frequency with a capacitance *per section* of (20) (1.25), or 25 $\mu\mu$f. Thus, L_5 should be designed so that condenser C_{15} resonates, on 20 meters, when it is about ⅛ meshed. Condenser C_{15} has a capacitance variation of 13 $\mu\mu$f minimum to 100 $\mu\mu$f maximum, or 87 $\mu\mu$f total effective *range*. Therefore, ⅛ of 87 $\mu\mu$f plus the 13 $\mu\mu$f minimum value provides a total of about 25 $\mu\mu$f per section, as desired.

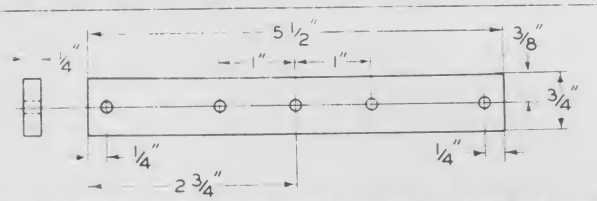


Figure 1—Outline drawing of Mycalex plug-and-jack strips used to mount the 812 plate coils. The jack strip is mounted directly on two opposite stator terminals of the condenser by two aluminum brackets. The end jacks go through both base strip and mounting brackets, thus forming the coil-condenser leads.

Capacitance Not Critical

It should be remembered, of course, that the exact capacitance value used is not critical because there is nothing "sacred" about a "Q" of 12. The use of a slightly larger "Q" is quite good design for telephony. A smaller "Q" (less tuning capacitance) should be avoided, however, in the interest of better modulation linearity and in the reduction of harmonics. It is advisable, as a general rule, to determine the desired value of capacitance from the TT-3 chart and then to use this value as a design factor toward which to work in making coils for each band. For C_{15}, the capacitance chart values per condenser section for 5-band operation are as follows:

10 meters	12.5	$\mu\mu$f per section*
20 meters	25	$\mu\mu$f per section
40 meters	50	$\mu\mu$f per section
80 meters	100	$\mu\mu$f per section
160 meters	200	$\mu\mu$f per section

* More capacitance must actually be used, because the minimum capacitance of C_{15} is 13 $\mu\mu$f.

It is apparent that, for this particular rig, the Cardwell plate condenser "MT100GD" (100 $\mu\mu$f per section) is just large enough for 80 meters with the plates fully meshed, and has a minimum capacitance just low enough for a satisfactory "Q" at 10 meters with the plates only slightly meshed. For 160-meter operation, it is advisable to add a 75-$\mu\mu$f fixed air condenser of the plug-in type across the entire plate coil (L_5). This is the same as adding 150 $\mu\mu$f per section to C_{15} as a *minimum capacitance value*. The fixed air condenser must have twice the air gap of C_{15}; that is, an air gap of at least 0.14" is needed in order to withstand the peak-to-peak r-f voltage across L_5. The r-f voltage at one end of the plate coil reaches a positive peak at the same instant the r-f voltage at the other end reaches a negative peak, and the peak-to-peak value is twice the peak value as measured to the center of the coil or to the rotor frame of C_{15}. A fixed air condenser such as Cardwell type JTT-75-OS or equivalent meets these specifications. Provision should be made for mounting it on the chassis at the right of C_{15}, if 160-meter operation is contemplated. Such provision was not made with the layout illustrated in the photograph, but a suitable re-arrangement of the parts is readily possible.

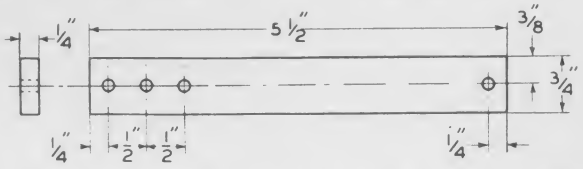


Figure 2—Outline drawing of plug-and-jack strips used to mount the 807 plate coil. The jack strip is mounted to the front frame screw and to the rear stator terminal of C_4 by means of aluminum brackets. The Mycalex strips come in 11-inch lengths and were obtained from the Allen D. Cardwell Co. Each length provides two coil strips.

Capacitance Adequate For All Bands

The capacitance of either C_4 or C_9, as specified in the legend, is adequate for all bands from 10 to 160 meters. In designing the coils for the 807 plate tank, one can again use the TT-3 capacitance chart. At 600 volts and 60 ma. (for the 807), a value of 1.25 $\mu\mu$f per meter is again indicated, by co-incidence. Knowing the desired capacitance for each amateur band, one can readily design the various coils by using one of the well-known inductance formulas or charts as a guide, assisted by prior experience, along with a generous helping of "cut, try, squeeze, and pull."

Knowing the desired value of *total effective tuning capacitance*, one can obtain the value of the required inductance from the formula,

$$L = \frac{25.33 \times 10^9}{f^2 C}$$

where "L" is in microhenries, "f" is in kilocycles per second, and "C" is in micro-microfarads. In the case of the 20-meter final amplifier tank circuit, the total *effective* capacitance across the entire

R-F Tube Cost of 450-Watt Rig Only $11.50

(*Continued from page 2, column 4*)

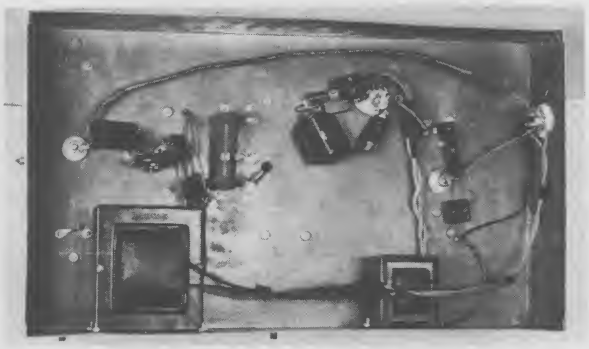
plate coil should be 12.5 $\mu\mu$f—one-half of the 25 $\mu\mu$f *per section* value previously mentioned. Inductance L_6, as specified, is just a bit too small to resonate with this capacitance. Two more turns—14 instead of 12—may more nearly give the desired LC combination. Likewise, L_1 tunes to 14 Mc. with 58 $\mu\mu$f of capacitance, and therefore should be slightly larger than the size specified in order to meet the theoretical design requirements previously outlined.

In none of these calculations have tube-output or circuit-wiring capacitances been mentioned. Wiring capacitances, in a well-designed transmitter layout, are usually negligible at frequencies up to 60 Mc. The effective output capacitance of two triodes in a push-pull stage is equal (approximately) to ½ the plate-filament capacitance plus the grid-plate capacitance ($\frac{1}{2}C_{pf} + C_{gp}$). The two 812's, therefore, have a total effective output capacitance of 0.4 + 5.3, or 5.7 $\mu\mu$f. Theoretically, in a push-pull stage, *twice* this value of capacitance (11.4 $\mu\mu$f) should be subtracted from the *per section* condenser values obtained for each amateur band from the capacitance chart. At 30 Mc, the tube capacitance obviously represents the largest part of the total 12.5 $\mu\mu$f per section required, even neglecting the minimum capacitance of C_{15}. The best procedure, therefore, is to design L_6 for 10 meters so that C_{15} tunes practically all the way out. These considerations show clearly why LC values become increasingly important at frequencies of 14 Mc and higher.

To return now to our description of the 812 rig, the top-view photograph does not show the two-turn output link coil (L_6) around the center of L_5, although plug-and-jack connections are provided for it on the mounting strips. This link can be wound with #12 solid wire with a diameter about ½ inch larger than the diameter of L_5. The wire should either be insulated for 3000 volts with high-quality spaghetti tubing or separated from L_5 by ceramic spacers, so that it can in no case come in contact with the high d-c plate voltage on L_5. The short +B lead from the center plug to the center tap of L_5 should be covered with heavy spaghetti tubing or else heavily taped.

The bottom-view photo of the chassis shows the location of the various filament transformers, resistors, by-pass condensers, and other parts. A separate filament transformer is used for the 812's so that the final stage can be keyed in the filament center-tap circuit, if desired. A keying relay can be placed under the chassis for this purpose, along with a key click filter, because plenty of extra space is available.

If the amplifier chassis is mounted in a rack, the meter connections to the 807 and 812 stages are simplified by mounting the four meters on the amplifier panel. If a separate meter panel is used, several meter leads must be brought out by means of a terminal jack or strip. Of course, a single meter with a plug-cord can be used by placing closed-circuit meter jacks in place of the various meters. It is important, however, to leave the 500-ma. final-stage plate meter *permanently* wired in the cathode circuit at all times. This meter, connected as shown, will not include the grid current in its reading.



The under-chassis view also shows the remarkable simplicity of construction of this fine performing transmitter.

The r-f input to the 807 is fed through the 10-70-$\mu\mu$f mica trimmer (C_1), which is located at the grid terminal of the 807 socket. The exciter unit, which can consist of a 6V6-G or 6L6-G "Tritet" crystal oscillator, should normally be located on a chassis immediately below the power amplifier. The 807 excitation lead can then be made quite short. A phone-tip plug-and-jack inserted in this lead will allow the two units to be readily disconnected for removal from the rack. A suitable "Tritet" oscillator is shown in circuit UC-1 in "Ham Tips" for September, 1938.

Tuning the Transmitter

In tuning up the rig for the first time, one should tune one stage at a time, beginning with the oscillator, and leaving the plate voltage *off* the 807 and the 812's. After the 807 grid-current meter shows that the oscillator is functioning properly (a d-c grid current of 3 to 5 ma. is proper for the 807), a 5000-ohm 200-watt protective resistor should be inserted in the 807 +B lead. The resonant point on C_4 can then be found without danger of overloading the 807 during the tuning procedure. The protective resistor should then be removed. Next, L_2 and C_9 should be adjusted for proper coupling and resonance, respectively, as indicated by the 812 grid meter.

With full plate voltage on the 807, the 812 grid meter should read somewhat higher than the desired operating value of 50 ma., because the amplifier grid current drops when the 812 plate voltage and plate load are applied. The next step, before the high voltage is placed on the final stage, is the neutralization of the 812's. A small neon bulb and a Bakelite-rod type of screw driver are handy tools for the proper adjustment of C_{10} and C_{11}. The shafts of these condensers are conveniently slotted for this purpose. The rear neutralizing condenser requires setting at a slightly higher capacitance than the front one, due possibly to the fact that its lead to the grid of the rear 812 is just slightly longer (and has a little more capacitance to ground) than the corresponding front lead. This difference is of no practical importance in the operation of the amplifier, however. After an r-f voltage minimum (shown by the neon bulb) has been established at both ends of L_5, the final amplifier grid meter should not "kick" perceptibly when C_{15} is tuned through resonance. It is essential, of course, constantly to retune C_4, C_9, and C_{15} as the neutralizing adjustments are being made, due to circuit interaction.

Protective Resistor in B+ Lead

The lusky 5000-ohm protective resistor should next be placed in the +B lead to the 812's, and the resonant point on C_{15} located. The absence of a resonant point usually means that L_5 is either too big or too small for the tuning range of C_{15}. If a protective resistor is *not* used, the 500-ma. plate-current meter will bang off scale with a somewhat terrifying speed! "Spotting" of the zirconium-coated 812 plates, while not damaging to the tubes (see "Ham Tips," Oct., 1939), is undesirable and can be easily avoided by means of the protective resistor while the initial tuning is in progress. Once the resonant point is determined for a given band, the dial reading should be noted, so that the condenser can be pre-set in future "tunings up" after band changing. This also applies to the 807-stage dial setting.

All operating tests were made on 14 Mc. The final-stage plate current dips to about 30 ma. at no-load resonance. Pencil tests are *not* recommended to determine how large an r-f arc can be drawn from the final plate tank, because of safety considerations. Besides, the pencil catches on fire.

In the particular test made on this rig at the station of W2BRO, the 2-turn output link (L_6) was coupled to a half-wave "Zepp" antenna coil by means of a few feet of twisted pair terminated by another 2-turn link. The 812's loaded to 250 ma. very easily. Variation of the link coupling at the antenna tuned circuit was necessary because the coupling of L_6 was fixed. A swinging-link assembly at L_5L_6 would be more convenient, if commercial plug-in coils were used.

May Be Modulated with Pair 811's

A logical, economical modulator for the 812's is a pair of RCA-811's in class B, driven in turn by a pair of 2A3's, or by a pair of 6L6's in class AB_1 with inverse feedback. A circuit of the latter type is shown on page 4 of Oct., 1939, "Ham Tips." With 1250 plate volts and zero bias, two 811's will deliver about 175 watts of a-f power. The push-pull 812's require only 155 watts of audio for 100% plate modulation, which means that some surplus modulating power is available from the class B 811's.

An oscillograph pattern of the r-f output, with a steady sine-wave signal, showed the modulation to be quite linear. No trouble was had with arc-overs or distortion at 100% modulation, even when an overload test was made with 1500 volts on the 812 plates.

CW Operation of 812's

For cw operation, the 812's can be run at the ICAS ratings of 1500 volts and 300 milliamperes. The grid leak (R_4) should be changed to 3500 ohms (20-watt size). The keying relay contacts can be placed in the lead coming from the center tap of filament transformer T_2. However, because the filaments of the 812's assume the d-c plate potential when the key is up (the tubes act somewhat like an unloaded rectifier), filament by-pass condensers C_{12} and C_{13} must be changed to a high-voltage type—a rating of 2500 volts being adequate. An alternative by-passing arrangement is shown in circuit UC-23 in October, 1939 "Ham Tips," using one high- and two low-voltage condensers. A key-click filter will be found essential with this type of keying circuit.

Slightly more excitation is needed for cw operation of the 812's; this can be obtained by adjusting the coupling of L_2 and L_1. Oscillator keying is *not recommended* for the circuits shown. For this type of keying, the 807 screen voltage would have to be obtained from a fixed, low-voltage source; in addition, partial fixed bias of near-cut-off value in conjunction with reduced values for grid leaks R_1 and R_4 would be required for both stages.

Substituting 811's

The only changes required in order to use plate-modulated push-pull 811's are in the grid excitation and in the value of the amplifier grid leak. The coupling of L_2 and L_1 must be tightened so as to increase the total amplifier d-c grid current from 50 ma. to 100 ma. The grid leak R_4 must be changed from 2500 ohms to 1250 ohms (20-watt size). The d-c plate current of the 807 driver should then be about 100 ma.—the maximum rated value for this tube. The 812's will load the 807 only to about 50 or 60 ma.

For cw operation with 811's, the grid leak R_4 should be made about 1700 ohms (20 watts). Partial fixed

(*Continued on page 4, column 4*)

FINE LOW-POWER RIG MADE WITH 6L6-G/809 TUBE COMBINATION

CM2AD Wins Tube for Circuit "Tip"

The excellent r-f amplifier characteristics of the RCA-809, together with its unusually low price, has made this tube one of the outstanding amateur favorites. The fact that the 809 requires relatively little driving power and operates at a moderate plate voltage makes it well suited for use in simple, low-power transmitters such as most beginning (and many old-time) amateurs take delight in constructing and operating.

The circuit of Fig. 3, submitted as a "ham tip" by Cuban CM2AD, shows a 6L6-G crystal oscillator-doubler driving an 809 final amplifier (CM2AD wins one 809 for this contribution). This rig is illustrated in the photo, with the 20-meter coils in place. A 40-meter crystal is employed with "straight-through" operation for that band. On 20 meters, the oscillator plate tank is tuned to the second harmonic of the crystal. The 809 is driven to a d-c grid current of 30 ma. on both 20 and 40 meters, with about the same d-c plate input (15 watts) to the oscillator in either case. CM2AD suggests that his inefficient 40-meter oscillator plate coil, wound on a tube base, may account for the fact that he does not get more drive on 40 than on 20 meters. In any event this arrangement is certainly good design, because he does not have to change the excitation to the 809 when changing bands. The 809 plate current at no-load resonance dips to 23 ma. on 40 meters and to 14 ma. on 20 meters, indicating that the amplifier plate-circuit efficiency is fairly high. The 809 loads to 100 ma. quite easily when the antenna load is coupled in by L_3.

Uses Plate Modulation

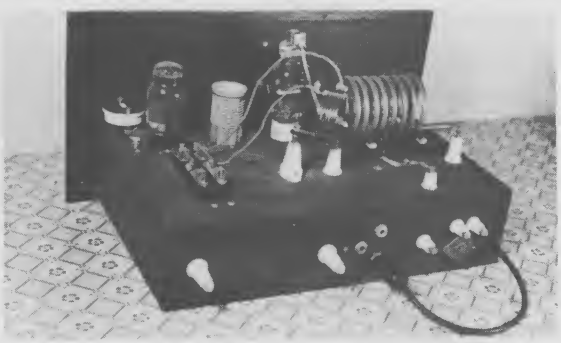
CM2AD reports also having used plate modulation with this rig. He pushes the 809 grid current up to 35 ma. for 'phone, by increasing the oscillator plate voltage slightly. C_{11} should have a 2000-volt rating and C_9 a 3500-volt rating for plate-modulated operation.

The oscillator plate voltage is taken from a tap on a 25000-ohm, 200-watt bleeder across the 750-volt plate supply. Although CM2AD did not mention trouble from "chirps" when the 6L6-G is keyed, it is possible that a steadier note can be obtained by using a fixed tap on the voltage divider for the oscillator screen voltage, instead of a series screen resistor.

The oscillator circuit appears to be a "Tritet" *without* a tuning condenser across the cathode coil. The by-pass condenser shown in Fig. 3 in dotted lines was not included on CM2AD's original sketch. It may be required in some layouts, inasmuch as it furnishes the 6L6-G cathode circuit with a short r-f return path to ground. In this rig, however, the by-passing through C_7 and C_8 is adequate. The use of the extra condenser might require a slightly different value of inductance for cathode coil L_4.

This little rig has given CM2AD real results. He lists his dx as 62 countries, WAC, and WAS. Many "kilowatters" have done less!

In a letter dated September 25, 1939, CM2AD reports that he is terribly disappointed over the Cuban Government's decision to *cancel all Cuban amateur licenses*. He believes, however, that new regulations permitting amateur operation are in the "offing." Along with him, we certainly hope so! In the meantime, our heartfelt sympathies to a silent neighbor.



CM2AD rakes in a 5-spot for this photo of his simple, two-tube rig using an RCA-6L6-G to drive an RCA-809 on 20 or 40 meters. Circuit is shown in Fig. 3. He reports having built three rigs of this type for friends—and that they all worked equally well. See accompanying story for more details.

NEW CHART

Your RCA Power Tube Distributor now has a large chart showing the superior values of RCA Power Tubes. Be sure and check this chart before making any power tube purchase.

New RCA Dual Ratings Meet Wide Approval

(*Continued from page 1, column 1*)

"in between" power ratings. That is, the gap in power capability between any tube and the next larger size has been materially reduced.

For those who missed the announcements carried in October "Ham Tips" and in November QST and RADIO, a brief description of the new RCA Dual Rating System is in order. Instead of one set of maximum ratings for each tube type, *two* sets of maximum ratings are given. These ratings are designated "Continuous Commercial Service (CCS) and "Intermittent Commercial and Amateur Service" (ICAS).

CCS Same As Former Ratings

The CCS ratings are essentially the same as the former maximum ratings. The ICAS ratings, however, are considerably higher, permit the use of much greater power input, and provide a relatively large increase in useful power output. For example, the a-f power output of two 809's in class B is 100 watts at the old maximum plate-voltage rating of 750 volts. At the new ICAS rating of 1000 volts, the power output is 145 watts—an increase of 45 per cent. In plate-modulated telephony service, the r-f output of the 809 is 38 watts with the CCS ratings and 55 watts with the new ICAS ratings—also an increase of about 45 per cent.

The new system provides transmitting-tube ratings which recognize the diversified design requirements of modern transmitter applications. For example, there are numerous applications where the design factors of minimum size, light weight, low initial cost, and maximum power output are far more important than extremely long tube life. In such cases, the set designer may very properly decide that a small tube operated with ICAS ratings better meets his requirements than a larger tube operated with CCS ratings.

To meet the large demand for data on the new ICAS ratings, a 20-page booklet entitled INCREASED RATINGS, has been prepared and is available free on request from the Commercial Engineering Section, RCA Mfg. Co., Inc., Harrison, N. J.

R-F Tube Cost of 450-Watt Rig Only $11.50

(*Continued from page 3, column 4*)

bias is not needed for the 811's when oscillator keying is employed, due to the zero-bias, high-mu design of this tube type. The 811 is, therefore, preferable to the 812 in this particular type of service. If center-tap keying of the final stage is to be used, there is little to choose from between the 811 and the 812.

A subsequent issue of "Ham Tips" will describe a class B modulator using two 811's, together with a circuit of a complete speech amplifier and driver. The subject of cathode modulation is being given special attention. More on this later.

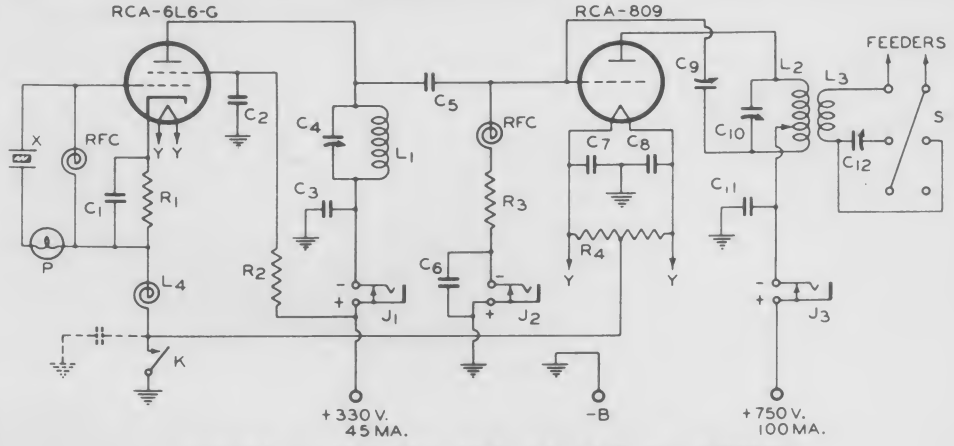


FIGURE 3—CW RIG FOR 40 AND 20 METERS

Power Output 55 Watts*

(Submitted by CM2AD, who gets one RCA-809 for this circuit suggestion)

C_1 = 40 $\mu\mu$f mica
C_2, C_3, C_6, C_7, C_8, C_{11} = 0.002 μf mica.
C_4 = 150 $\mu\mu$f midget variable.
C_5 = 50 $\mu\mu$f mica.
C_9 = 18 $\mu\mu$f neutralizer.
C_{10} = 100 $\mu\mu$f variable.
C_{12} = 350 $\mu\mu$f receiver type.
R_1 = 500 ohms, 5 watts.
R_2 = 20,000 ohms, 5 watts.
R_3 = 3000 ohms, 5 watts.
R_4 = 40 ohms, c.t., wire-wound.
K = Key.
L_1, L_2 = Tune to 7 or 14 Mc.
L_3 = Antenna coil—7 turns #14 enamel, 2" diameter.
L_4 = 10 turns #20 D.C.C., 1" diam., 2" long (see text).
RFC = 2½ mh. r-f choke—small size.
X = 40-meter crystal.
P = 6-8 V., 150-ma. tan bead pilot bulb.
S = D.P.D.T. feeder switch.
J_1, J_2, J_3 = Single-closed-circuit jack.
* Approximate.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation.

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HAM TIPS from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 3 — No. 1 CAMDEN, N. J. JANUARY—FEBRUARY, 1940

NEW SUPER HAS STABILITY AND SENSITIVITY PLUS

Uses Frequency Stabilizer and Voltage Regulator

"The AR-77 puts an end to dial twiddling when you give the other fellow the 'GA' to comeback." So enthuses Mr. Ed. Braddock, Manager of RCA Amateur Equipment Sales.

This new 10-tube super is designed with particular attention to frequency drift. Heat, the formidable enemy of frequency stability, is greatly minimized by using an over-sized power transformer. Furthermore, the careful selection and use of excellent insulation in strategic places minimizes circuit losses and detuning effects caused by changes in temperature and humidity. The new ultra-efficient insulation, POLYSTYRENE, is used in the two highest frequency r-f transformers and in the i-f transformers; ceramic insulation is used in the tuning condensers, band-change switch, and r-f trimmers. And last but not least, the AR-77 is equipped with a temperature-compensator that automatically corrects for frequency drift, particularly when the receiver first warms up from a cold start.

Plenty of Features

Greater approach to constant sensitivity throughout each tuning range is achieved by dual alignment of each tuned r-f circuit. This system maintains uniform tracking of the r-f, first detector, and the h-f oscillator circuits. The image ratio at 30 Mc is approximately 40 to 1 with a 50-ohm load. Electrical band-spread tuning is used. The band-spread dial is calibrated for 10, 20, 40 and 80 meters and spread out over approximately 270°. After band switching, accurate resetting of the receiver is made practical by a vernier-index scale which may be used for both the main-tuning and band-spread dials.

Other features of the AR-77 include the use of a voltage regulator for the plate supply of the h-f oscillator and first detector, a sure-fire noise limiter, and a carrier-level meter. Negative feedback is employed in the a-f output circuit for improved fidelity.

The AR-77 uses one single-ended RCA-6SK7 in the tuned r-f stage, two 6SK7's in each of the two i-f's, a 6K8 first detector and oscillator, a 6H6 second detector and noise limiter, one 6SQ7 a.v.c. and a-f amplifier, one 6F6 a-f power amplifier, one 6SJ7 as b.f.o., one 5Z4 rectifier, and one VR-150/30 voltage regulator. Amateur net price of the AR-77 is $139.50; net price of the 8-inch dynamic speaker in matched cabinet, $8.00. Give this receiver a whirl at your nearest RCA distributor.

IT'S HERE!

The new, big RCA Receiving Tube Manual, the RC-14, is just off the press. This book now contains 224 pages brimful of tube theory, application, circuits, and charts—and above all, it includes up-to-the-minute information on a total of 237 different receiving tube types.

You can obtain a copy of this RC-14 from your RCA tube dealer, or by sending 25 cents to the Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, New Jersey.

COMING!

Featured in the next issue is a constructional story on an 811 class B modulator. Data will include curves for a-f power output, harmonic distortion, and frequency response, as well as circuits for a complete speech amplifier and class AB_1 driver. A constructional article on a 1250/1500 volt, 500-ma. power supply will also be included. This husky supply is designed to operate both the 811 modulator and the p-p 812 r-f stage (described in November Ham Tips).

Be sure to contact your RCA Transmitting Tube Distributor for the next issue of Ham Tips!

STEADY AS A ROCK

Frequency-drift compensation and tremendous usable gain makes the new AR-77 one of the most brilliant communication receivers ever hooked to an antenna. The AR-77 uses 10 tubes (5 high-gain single-ended types) and has a frequency range that extends all the way from 540 to 31,000 kc. It employs band-switching in 6 ranges with individual coils and uses a crystal filter with a 6-stage selectivity control that provides band widths from 6 kc to 80 cycles!

CATHODE MODULATION

The Whys and Wherefores

By E. E. Spitzer, A. G. Nekut, and L. C. Waller

Research and Engineering Dept., RCA Manufacturing Company, Inc., Harrison, N. J.

The subject of cathode modulation has recently received the spot light of amateur attention. The features of this modulation system have been described in a number of writings, notably those by Mr. Frank C. Jones. In this article, we shall discuss several aspects of cathode modulation from the viewpoint of the transmitting-tube engineer. It will be shown that, for a typical cathode-modulated stage, the modulating power required is approximately equal to 20 per cent of the d-c plate input to the modulated r-f amplifier. Furthermore, it will be shown that the cathode impedance of a typical single-tube r-f amplifier is about 6000 ohms; that of a typical push-pull stage about 3000 ohms.

An elementary circuit for cathode modulation is shown in Fig. 1. If some a-f modulating voltage, e_m, is introduced in the cathode or filament-return circuit of an r-f amplifier, this a-f voltage will modulate both the plate voltage and the grid voltage of the stage. Let us assume that on the

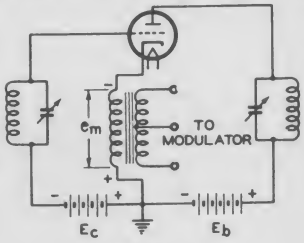

Figure 1

first half-cycle of the modulating voltage, the polarity of e_m is as indicated in Fig. 1. In the series circuit between the cathode and the plate, voltage e_m will *add* to the plate-supply voltage, E_b, because their polarities are correct for addition. The resulting increase in plate voltage will cause the plate current and amplifier power output to increase. In the grid circuit, however, e_m acts so as to oppose the grid-bias voltage, E_c. The resulting *decrease* in negative grid voltage will also cause the plate current and amplifier power output to *increase*. Thus, the effects of e_m on both the grid circuit and the plate circuit are *in phase*, because both effects tend to increase the amplifier power output. On the next half-cycle of modulating voltage the polarity of e_m is reversed, resulting

*See Reading List

(*Continued on page 3, column 1*)

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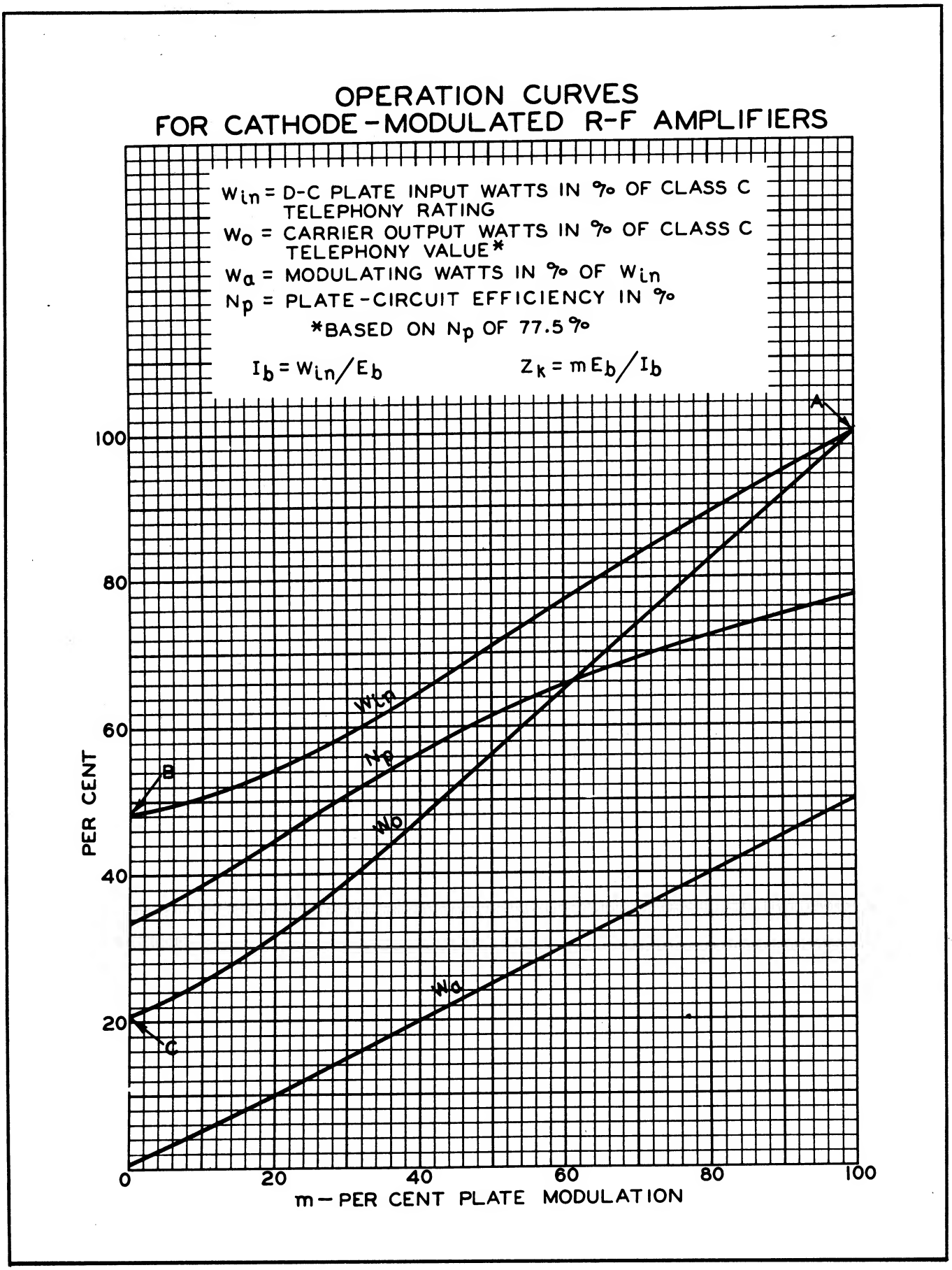
OPERATION CURVES
FOR CATHODE-MODULATED R-F AMPLIFIERS
Win = D-C PLATE INPUT WATTS IN % OF CLASS C TELEPHONY RATING
Wo = CARRIER OUTPUT WATTS IN % OF CLASS C TELEPHONY VALUE*
Wa = MODULATING WATTS IN % OF Win
Np = PLATE-CIRCUIT EFFICIENCY IN %
*BASED ON Np OF 77.5 %
Ib = Win/Eb
Zk = mEb/Ib
A
B
C
Wi
Wp
Wo
Wo
100
80
60
40
20
0
20
40
60
80
100
PER CENT
m — PER CENT PLATE MODULATION

Figure 2

Cathode Modulation

(*Continued from page 1, column 4*)

in less plate voltage, a larger negative grid bias, and a *decrease* in amplifier output. In other words, the effect of modulating voltage e_m, acting in the cathode circuit, is to produce simultaneous, in-phase, grid-and-plate modulation. Thus, 100 per cent modulation of the carrier can be accomplished by a combination of, say, 40 per cent plate modulation with 60 per cent effective grid modulation. For this reason—and for other reasons which will become apparent as we go along—we can think of the cathode system of modulation as "grid-and-plate" modulation.

Comparison of Modulating Systems

It is necessary at this point in our discussion to consider both grid modulation and plate modulation for a moment. The salient characteristics of these systems of modulation are well known.

Grid modulation results in
(1) Low power output
(2) Low plate-circuit efficiency
(3) Low audio power requirements

Plate modulation results in
(1) High power output
(2) High plate-circuit efficiency
(3) High audio power requirements

For example, a grid-modulated RCA-812 has a carrier output of 25 watts at a plate-circuit efficiency of about 33 per cent. The a-f power required for 100 per cent carrier modulation may be only 1 watt or so. The same tube, plate modulated, has a carrier output of 120 watts at a plate-circuit efficiency of about 77 per cent, but the modulating power required for 100 per cent carrier modulation is nearly 78 watts. A cathode-modulated amplifier may be adjusted to operate at any suitable point between these two extremes.

Determination of C-M Operating Conditions

The question immediately arises as to how to determine the proper operating conditions for a cathode-modulated stage. To simplify the problems involved, the four curves of Fig. 2 have been prepared. These curves are useful because they show what happens to the d-c plate input (W_{in}), the carrier output (W_o), the modulating power (W_a), and the plate circuit efficiency (N_p), as the percentage of plate modulation ($_m$) is varied from zero to 100 per cent.

The data for the curves of Fig. 2 were obtained for an RCA-812, but have been plotted on a percentage basis so as to be applicable to any tube or tubes for which the class C telephony ratings are known. That is, point "A" on the W_{in} curve represents the *rated class C plate-modulated telephony power input*, or 155 watts for the 812. All other values along the W_{in} curve can be determined as the indicated percentage of the value at point "A". Similarly, point "A" on the W_o curve represents the class C telephony carrier output (based on a plate-circuit efficiency of 77.5%), or 120 watts for the 812. Other values on the W_o curve are found by taking the indicated percentages of the value at point "A".

Point "B" on the W_{in} curve and point "C" on the W_o curve represent the values for "pure" grid modulation (where "m" is zero %). For the example of the 812, W_{in} at point "B" is 75 watts, or about 48% of 155 watts;

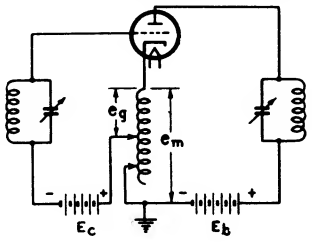

Figure 3

W_o at point "C" is 25 watts, or about 21% of 120 watts.

It is apparent that points "A", "B", and "C" are readily obtainable from the published values given in the tube bulletin. Intermediate points on the W_{in} and W_o curves were obtained as follows: In a test stage, a peak a-f voltage equal to ⅓ of the d-c plate voltage was applied to the plate circuit; this held "m" at 33⅓%. An in-phase grid-modulating voltage was then applied to the grid circuit so that an oscillograph pattern of the carrier showed 100% carrier modulation. This procedure was repeated for various values of grid bias, grid excitation, and plate loading until operating conditions were found which gave maximum power output without exceeding the tube's plate dissipation or producing objectionable distortion at 100% carrier modulation. The entire procedure was then repeated with "m" at 66%, or with 66% plate modulation. Thus, curves W_{in} and W_o provide data for the design of a cathode-modulated amplifier, expressed in terms of the class C plate-modulated telephony input and output.

Values for the plate-circuit efficiency curve (N_p) are easily obtained from the relation $N_p = (W_o/W_{in})(100)$, in per cent, where values of W_o and W_{in} correspond to various values of "m".

Data for the W_a (modulating power) curve are calculated from the relation

$$W_a = \frac{m}{2} W_{in} \text{ (approx.)}$$

where "m" is the percentage of plate modulation employed and W_{in} is the d-c plate input. This relationship is derived as follows (see Figs. 3 and 4): The a-f power, W_a, is equal to the product of the RMS a-f modulating voltage and the RMS a-f component of the plate current—that is, $W_a = (E_{ac})(I_{ac})$. If e_m is the peak a-f modulating voltage, $E_{ac} = e_m/\sqrt{2}$. Because the carrier is 100% modulated, the d-c plate current I_b is also modulated 100% (see Fig. 4). Therefore, the peak value of the a-f component of current is equal to I_b, and the RMS value is $I_{ac} = I_b/\sqrt{2}$. Thus,

$$W_a = \left(\frac{e_m}{\sqrt{2}}\right)\left(\frac{I_b}{\sqrt{2}}\right) = \frac{e_m I_b}{2}$$

Because $e_m = mE_b$, by definition of the plate modulation factor "m", we find that

$$W_a = \frac{m}{2} E_b I_b, \text{ or, } \frac{m}{2} W_{in} \text{ (approx.)}$$

This derivation neglects the fact that the cathode current flowing through the modulation transformer secondary is not I_b, but I_b plus the d-c grid current (I_c) of the r-f amplifier. However, since I_c is quite small compared to the d-c plate current, and since the grid current flows through only a small portion of the secondary winding (the part marked "e_g" in Fig. 3), it is permissible to neglect the effect of grid current in calculating W_a.

The equation for W_a is very interesting because it states that the modulating power required is m/2 times the d-c plate input to the cathode-modulated amplifier. The audio power required, therefore, varies with "m" and is not a fixed percentage of the d-c plate input. The commonly accepted "rule of thumb" for calculating the audio power states that W_a equals 10% of the d-c power input. This 10% rule is correct for the case where "m" is 20%, or where 20% plate modulation is employed. Reference to the curves of Fig. 2 shows that where "m" is 20%, the plate-circuit efficiency (N_p) is about 44%. This is somewhat lower than the commonly accepted figure of 50 to 60% for the efficiency of a cathode-modulated stage. Undoubtedly, N_p can be made as high as 50 to 60%, even when "m" is only 20%, provided the carrier is modulated slightly less than 100% and/or increased distortion is permissible.

Fig. 5—Comparative Performance of 2 RCA-812's, Push-pull

Plate Modulation Percentage (m)	20	40	100	
D-c plate voltage (E_b)	1250	1250	1250	volts
D-c plate current (I_b)	0.135	0.162	0.248	ampere
D-c plate input (W_{in})	169	202	310	watts
R-f carrier power output (W_o)	75	114	240	watts
Total max. plate dissipation required (W_p)	94	88	105	watts
A-f modulating power (W_a)	16.9	40.4	155	watts
W_a as a percentage of W_{in}	10	20	50	%
Plate-circuit efficiency (N_p)	44.5	56.5	77.5	%
Cathode impedance (Z_k)	1850	3090	5000	ohms
A-f power to *plate modulate* an equivalent carrier 100% (W_e)	48.5	73.5	155	watts
Ratio, $W_a/W_e \times 100$	35	55	100	%
Total max. plate dissipation required to give equivalent carrier (W_o) in a plate-modulated stage (W_t)	33	49.5	105	watts
Plate-dissipation ratio (W_p/W_t) for equivalent carrier (F)	2.85	1.78	1	

Plate-Circuit Efficiency About 55%

The question is sure to arise as to just what constitutes a properly designed cathode-modulated r-f amplifier. It can be answered simply if we make the logical assumption that a typical cathode-modulated stage is one in which *the plate-circuit efficiency* (N_p) *is just half way between the 33% (approx.) of pure grid modulation and the 77% (approx.) of pure plate modulation—that is, 55%.* In order to have N_p equal 55%, we find from Fig. 2 that "*m*" *must be almost 40%.* The a-f modulating power, W_a, is then *20% of the d-c power input.*

Another circuit value which is of primary importance in the design of a cathode-modulated stage is Z_k, the *cathode impedance* of the r-f amplifier. Z_k, in ohms, is approximately equal to the peak modulating voltage divided by the peak a-f component of plate current in amperes. Thus,

$$Z_k = \frac{e_m}{I_b} \text{ or, } m\,\frac{E_b}{I_b}$$

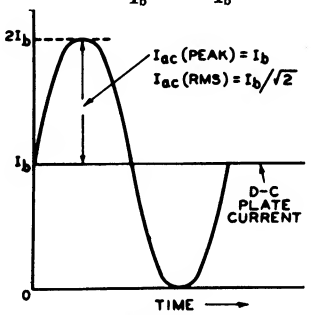

Figure 4

For a typical cathode-modulated r-f amplifier triode such as the RCA-812, operating at 1250 volts and 81 ma., Z_k turns out to be (0.4)(1250)/0.081, or 6180 ohms. Two 812's in push-pull or in parallel have one-half this cathode impedance, or 3090 ohms. If "m" is chosen as 20%, the values of Z_k become 3700 ohms and 1850 ohms, for the single 812 and the two 812's, respectively. To take an extreme case, a single RCA-852 operating at 2000 volts and 100 ma. has a cathode impedance of 8000 ohms (when "m" is 40%).

C. W. to 'Phone

Perhaps a practical way to design a cathode-modulated rig, especially where an existing cw transmitter is to be changed over to 'phone, is to begin with the largest modulator which we desire to use. Suppose this is to be push-pull 6L6's in class AB_2, delivering 55 watts of audio power. We then find, from the relation $W_{in} = \frac{2W_a}{m}$, that

$$W_{in} = \frac{(2)(55)}{0.4} = 275 \text{ watts. This}$$

(*Continued on page 4, column 1*)

Cathode Modulation

(*Continued from page 3, column 4*)

power is the maximum r-f amplifier input we can use with our 55-watt modulator, assuming "m" to be 40%. Let us assume, however, that Fig. 2 shows our r-f tubes to be capable of handling only 200 watts input. We must now resort to the relation

$$m = \frac{2W_a}{W_{in}}, \text{ or } m = \frac{(2)(55)}{200} = 0.55.$$

Thus, we can use 55% plate modulation and get a value of 64% for the plate-circuit efficiency (N_p). This means 128 watts of carrier output and 73 watts of plate dissipation—just about right *if* our push-pull final amplifier tubes are rated at 35 or 40 watts plate dissipation each. In other words, we can juggle the value of "m" up and down the scale until W_a is suitable for W_{in}, and until W_{in} is compatible with N_p *and* the rated plate dissipation of our r-f tubes.

Cathode-Modulated 812's

The curves of Fig. 2 will be found very useful in the design of any cathode-modulated triode r-f amplifier. As a specific example, suppose we are required to design a push-pull 812 rig so as to obtain an intermediate plate-circuit efficiency of about 56%, along with 100% carrier modulation and low distortion. Referring to the 812 tube bulletin, we find that the maximum ICAS values for plate-modulated class C telephony service are as follows (2 tubes):

D-c plate voltage (E_b)	1250 volts
D-c plate input (W_{in})	310 watts
R-f power output (W_o)	240 watts†

We already know that "m" is approximately 40%, or 0.4, for our typical cathode-modulated stage. Applying this value of "m" to the W_{in} curve of Fig. 2, we find that W_{in} is 65% of 310, or (0.65) (310) = 202 watts. Similarly, W_o is found to be 47.5% of 240, or (0.475) (240) = 114 watts.

The d-c plate current I_b is equal to W_{in} divided by E_b; hence, $I_b = 202/1250 = 0.162$ ampere. The audio modulating power equals $\frac{m}{2} W_{in}$, or $\frac{(0.4)(202)}{2} = 40.4$ watts. The cathode impedance into which our modulator must work is $Z_k = m\ E_b/I_b$, or (0.4) (1250)/0.162 = 3090 ohms. The same calculations have been made for the push-pull 812's using a value of 20% for "m", and all results tabulated in Fig. 5, for quick comparison with the 100% plate-modulation conditions listed in the fourth column of Fig. 5. The data in this table bring out several interesting facts. The ratio W_a/W_o is 55% when "m" is 40%. That is, the a-f modulating power required for such a cathode-modulated stage is only 55% as large as for a plate-modulated stage delivering the *same carrier output*. Only 35% as much a-f power is required for cathode modulation when "m" is reduced to 20%. In the latter case, however, the plate-circuit efficiency is reduced to 44.5%, because the tube operating conditions approach more closely those of pure grid modulation.

†Based on a plate-circuit efficiency of 77.5%.

Plate-Dissipation Comparisons

The factor "F" in Fig. 5 indicates the relative size (in terms of plate dissipation) of the tubes required for cathode modulation as compared to the size of tubes for a plate-modulated stage of the same carrier output. Where "m" is 20%, a cathode-modulated tube must have a maximum plate dissipation 2.85 times as large as the maximum plate dissipation of a plate-modulated tube. For example, a pair of plate-modulated 812's with an input of 310 watts will deliver a 240-watt carrier and must be capable of handling, at 100% modulation, a total plate dissipation of 105 watts. A pair of cathode-modulated 810's with an input of 450 watts will also deliver a 240-watt carrier, but they must be capable of handling (at zero modulation) a total plate dissipation of 300 watts. These figures check the value of "F" previously mentioned—that is, 300/105 = 2.85. When "m" is 40%, "F" is 1.78, the reduced value being due to the higher value of plate-circuit efficiency.

The tabulated data in Fig. 6 give a still better comparison of cathode modulation and plate modulation. It so happens that push-pull 809's, plate modulated, provide the same carrier output as push-pull 812's, cathode modulated. This table shows that the cathode-modulated stage requires 1.37 times as much d-c plate input and 1.78 times as much plate-dissipation, but only 0.55 times as much a-f power.

The d-c plate voltage employed for a cathode-modulated r-f amplifier can be the same as the maximum rated voltage for plate-modulated telephony service. The maximum rated plate voltage for class C telegraphy can be used if desired, provided $E_t + m\ E_t$ is not greater than $2\ E_p$, where E_t and E_p are the maximum rated voltages for telegraphy and telephony, respectively.

The maximum d-c plate current (I_b) for any cathode-modulated tube should never exceed the maximum rated current value for plate-modulated telephony. For example, 125 ma. is the maximum rating for a single RCA-812, cathode modulated. In most cases, of course, E_b is chosen first, W_{in} is determined from Fig. 2, and I_b is automatically fixed by the relation, $I_b = W_{in}/E_b$.

In order to obtain the desired percentage of plate modulation (m) in a cathode-modulated stage, it is necessary not only to have sufficient modulating power available, but also to adjust carefully the grid-return tap on the transformer secondary. The a-f grid voltage can be varied, as shown in Fig. 3, by means of a number of low-impedance taps on the cathode end of the transformer secondary. This winding should also include suitable taps to provide the desired value of cathode impedance.

The higher the "mu" or amplification factor of the r-f amplifier tube, the smaller the a-f grid voltage (e_g) required to produce a given percentage of effective grid modulation. The proper adjustment of a cathode-modulated stage, designed for any given value of "m", will occur when the value of e_g is the *minimum* necessary to produce 100% carrier modulation without unreasonable distortion. Careful adjustment of d-c grid bias, r-f grid excitation, and output loading are required in order to obtain correct operation. A cathode-ray oscillograph will be found of great assistance in making these circuit adjustments.

Conclusion

In our discussion so far we have been primarily interested in the mechanics of cathode modulation as regards what it is, how it is applied, and how it affects tube operating conditions. Of perhaps more importance in the final analysis, is the answer to the question, "Of what value is it?" Because the answer to this question depends on many external factors, we shall proceed on the basis of comparing cathode modulation (C.M.) to the system now in general use, i.e., plate modulation (P.M.).

It should clearly be understood that the following statements apply to modulated r-f amplifier stages having *equivalent carrier outputs*, as distinguished from a given type of tube modulated by one method or the other. C.M. requires larger r-f amplifier tubes having more plate dissipation capability, but uses considerably less audio-modulating power and a smaller, less expensive a-f transformer. C.M. requires a larger d-c plate input and a larger power supply for the r-f amplifier, but permits the use of a smaller, lower-voltage power supply for the modulator. A C-M stage is not quite as easy to adjust for optimum operation, but this is not a serious objection, especially where an oscillograph is available for test purposes. C.M. is much better suited for changing over a high-power cw transmitter to 'phone operation, where medium efficiency and power output are permissible, where low audio power is desired, and where the number and cost of circuit changes must be held to a minimum.

In the design of an entirely new 'phone transmitter, the choice between C.M. and P.M. for a given carrier output must necessarily depend on a *precise cost analysis* of each type of transmitter, complete in every important detail. The increased size of r-f tubes and their power supply for C.M. must be balanced against the reduced size of the modulator and its auxiliary equipment. One possibly important advantage of a C-M transmitter depends on the amount of cw operation contemplated. For example, referring to Fig. 6, let us assume that the *total net cost* of the plate-modulated 809 rig turns out to be *no more* than that of the cathode-modulated 812 transmitter. The 812 rig operated in class C telegraph service *will probably deliver an output of 230 watts*, whereas about 115 watts is all that could be obtained from the 809's, assuming that the plate voltage is not changed in either case. The plate current of the 812 stage would be pushed up to about 250 ma. This would not overload either the tubes or the power supply because in telegraph service the load is of an intermittent nature and the plate-circuit efficiency can be made quite high. The 812's would require somewhat more grid excitation, of course, but some surplus is usually available from the buffer stage.

Unquestionably, cathode modulation deserves far more attention than it has so far received, not only for use in amateur transmitters, but also in certain other specialized services. Mr. Frank C. Jones deserves much credit for the work he has done in focusing attention on this system of modulation.

Fig. 6—Plate-Modulated 809's Versus Cathode-Modulated 812's For Equivalent Carrier Output

Tube Type—2 in push-pull	809's	812's
R-f carrier output, watts	114	114
Type of modulation	Plate	Cathode
Carrier modulation, per cent	100	100
Percentage of plate modulation (m)	100	40
Percentage of effective grid modulation	0	60
D-c plate voltage, volts	750	1250
D-c plate current, milliamperes	196	162
D-c plate input, watts	147	202
A-f modulating power, watts	73.5	40.4
Plate-circuit efficiency, per cent	77.5	56.5
Plate dissipation at zero modulation, watts	33	88
Plate dissipation at 100% carrier mod., watts	49.5*	71.4**
D-c plate input ratio, C.M. to P.M.#	-------	1.37
A-f power ratio, C.M. to P.M.#	-------	0.55
Plate-dissipation ratio, C.M. to P.M.#	-------	1.78

* At 100% carrier modulation, both the plate power input and the carrier output increase 50%. Thus, plate dissipation also increases 50%, since the efficiency is practically constant.

** At 100% carrier modulation, the plate power input increases only m/2%, or 20% where "m" is 40%. The carrier output, however, increases 50% as before. Thus, plate dissipation *decreases* about 19%. It is interesting to note that when $m = N_p$, the plate dissipation is *constant* at both zero modulation and 100% carrier modulation. When "m" is 68.5%, N_p is also about 68.5%. Under these conditions, the plate will operate at an *even temperature*, either with or without modulation.

\# This factor applies to any C-M stage where "m" is 0.4, or 40%.

READING LIST

(1) CATHODE MODULATION (a manual) by *F. C. Jones*, Pacific Radio Publishing Co., Inc., San Francisco, California.

(2) CATHODE MODULATION by *F. C. Jones*, RADIO, October, 1939.

(3) CATHODE MODULATION by *F. C. Jones* and *F. W. Edmonds*, QST, November, 1939.

(4) MORE ON CATHODE MODULATION by *F. W. Edmonds*, QST, December, 1939.

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HAM TIPS from RCA

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VOL. 3—No. 2 CAMDEN, N. J. MARCH—APRIL, 1940

NEW BOTTLES PUT OUT REAL POWER ON U. H. F.'s

AR-77 FEATURES HIGH SIGNAL-TO-NOISE RATIO

Builds Up Weak Sigs Ordinarily Lost in Receiver Background Noise

By Edward Braddock

Manager of RCA Amateur Equipment Sales

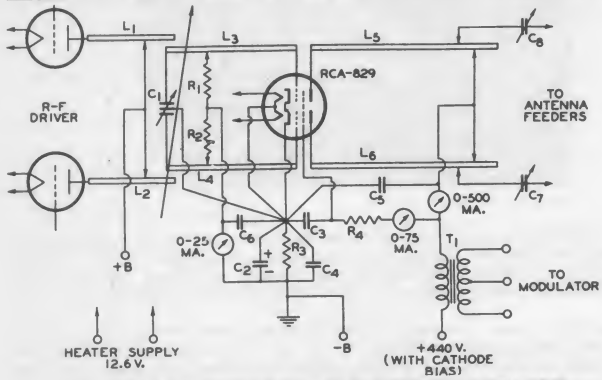
One of the most important yardsticks for measuring the performance of a receiver is its Signal-to-Noise Ratio. This measurement indicates the degree of receiver sensitivity and is defined as the ratio between the developed signal voltage and the developed circuit noise voltage. The higher this ratio is, the better is the signal intelligibility.

Modern tube developments have advanced circuit sensitivity to such a high degree that certain objectionable physical phenomena occurring in the tube circuit and in the tube itself actually become audible when receiver gain is advanced. In other words, inherent tube sensitivity has advanced the threshold of weak signals so much that it has brought to light other circuit limitations. These objectionable physical phenomena show up in receiver output as a steady hissing noise which can be loud enough to cover up an otherwise readable signal. The common expression "down in the mud" well describes a weak unintelligible signal mixed up in such a background.

AR-77 Has High Sig./Noise Ratio

In the design of the new AR-77 Communication Receiver, RCA engineers recognized from the start the vital importance of designing a superior receiver with an improved signal-to-noise ratio, particularly for the amateur bands where some of the choicest DX contacts require reception of extremely weak signals—signals that

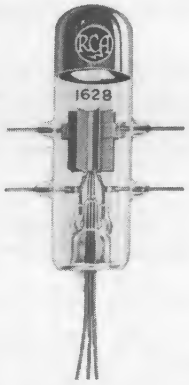
(*Continued on page 2, column 3*)



RCA-829 200-Mc R-F POWER AMPLIFIER

R_1 R_2 = 7500 to 15000 ohms, 1 watt.
R_3 = 60 ohms, 10 watts.
R_4 = 6400 ohms, 15 watts.
T_1 = Modulation Transformer.
C_1 = 1.2 to 10 $\mu\mu$f per section.
C_2 = 25 μf, 200 volts.
C_3 C_4 C_5 C_6 = 500 $\mu\mu$f, Mica.
C_7 C_8 = 3 to 35 $\mu\mu$f.

MEGACYCLES? — GOING UP!

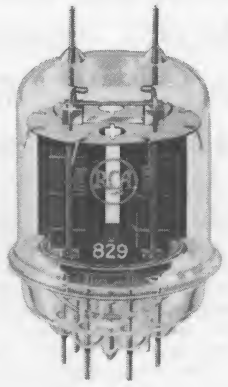


The new RCA-1628 transmitting triode takes maximum ratings as high as 500 Mc and reduced ratings up to 675 Mc.

LATEST XMTG TUBES MEET DEMAND FOR TYPES IN THE H-F SPECTRUM

RCA-829 Needs No Neutralizing to 250 Mc; RCA-1628 Takes Max. Ratings to 500 Mc!

FISTFUL OF POWER



New P-P Beam Power RCA-829 takes 120 watts at the handy plate voltage of 500 volts. Goes all the way to 1½ meters. Only 4 5/16" high and 2⅜" in diameter.

Filled is that long need by experimenters for transmitting tubes that will "deliver the goods" at the ultra-high frequencies. The newly announced Push-Pull Beam Power Amplifier RCA-829 and the double-lead H-F Triode RCA-1628 are capable of kicking out plenty of power at the ultra-highs with good efficiency and low driving power. In properly designed circuits, these tubes perform as smoothly at a few meters as they do at several hundred.

829 Two Tubes in One

The RCA-829 contains two beam power units within one bulb. The cathodes are connected together within the tube. The heaters are connected in series. The center heater connection is brought out of the bulb to a separate terminal to permit either series operation from a 12.6-volt supply or parallel operation from a 6.3-volt supply. Maximum

(*Continued on page 2, column 1*)

PRICES GREATLY REDUCED

We are pleased to announce *substantial* price reductions on three important transmitting tubes, as follows:

Type	Previous Net Price	New Net Price
813	$28.50	$22.00
832	28.75	17.00
1624	4.75	3.50

As you know, the 813 is a high power beam type capable of taking 360 watts input up to 30 Mc. At the new net price of $22.00, this tube now gives more than 16 watts/dollar—in addition to its inherent features of making it practical to reduce the number of driver stages and to eliminate neutralizing worries. Only ½-watt of r-f drive is required at 2,000 volts. When used as a crystal

(*Continued on page 3, column 1*)

READY FOR YOU

Too big to squeeze into this issue of Ham Tips and too good to split into serials, that hot constructional story on the 225-watt 811 class B modulator and its associated 750-watt high-voltage power supply we've been promising is now available in a separate and complete bulletin. Data includes photographs, layouts, a-f power output curves, harmonic distortion curves, and frequency-response curves, as well as circuits for a complete speech amplifier and class AB_1 driver. The design of the 1250/1500 volt, 500-ma. power supply also is included. This supply is capable of operating both the 811 modulator and a p-p 812 r-f amplifier (described in November Ham Tips).

Write to the RCA Manufacturing Company, Inc., Commercial Engineering Section, Harrison, New Jersey, for your free copy.

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New Bottles Put Out Real Power on U. H. F.

(*Continued from page 1, column 4*)

CCS ratings of the tube in class C telegraph service are: D-c plate voltage, 500 volts; total maximum d-c plate current, 240 milliamperes; and total maximum plate dissipation for both units, 40 watts. *Maximum plate input is 120 watts!* Typical power output is approximately 83 watts.

The exceptional efficiency and high power sensitivity of the tube permit full power output with very low driving power. For example, a single 829 operated in push-pull class C telegraph service is capable of handling its rated power input of 120 watts with less than a watt of r-f grid drive —at frequencies as high as 200 Mc (1½ meters). The tube may be operated with reduced ratings at frequencies as high as 250 Mc. Outstanding among the features of the 829 is the fact that it can be operated at these extremely high frequencies without neutralization, provided, of course, that the circuits are adequately shielded.

Symmetry is Keynote

The unusually fine performance of the 829 at the ultra-high frequencies is made possible by the balanced and compact structure of the beam power units, excellent internal shielding, and close electrode spacing. Furthermore, the internal leads are short and heavy to minimize internal lead inductance. The terminals are arranged to provide excellent insulation and to facilitate symmetry of circuit layout.

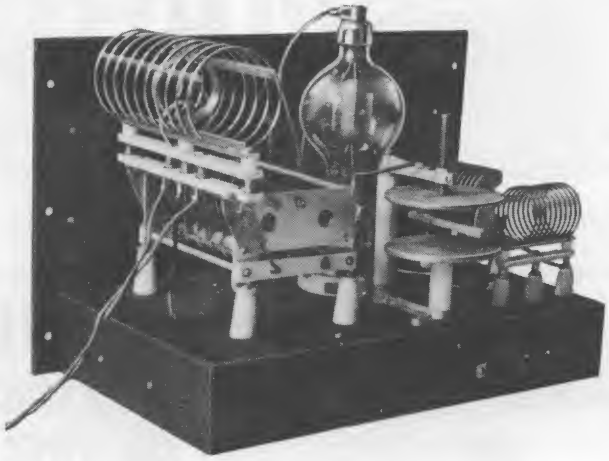
A 200-Mc. circuit employing the 829 is shown on page 1. Plate-circuit tuning is accomplished by adjustment of the shorting bar along the plate lines L_5L_6. These lines are made of ⅜″ diameter copper tubing, approximately 7″ long and spaced approximately ⅞″ between centers. Grid-circuit tuning is accomplished by C_1 which shunt tunes the grid lines. L_3L_4 are each made of ¼″ copper tubing, approximately 10″ long and spaced approximately ⅞″ between centers. They are ½-wave long each. The grid resistors should be adjusted on L_3L_4 at the voltage node. Dimensions of the driver plate lines are dependent on the type of driver tube used. Ordinarily they are approximately the same as L_5 and L_6.

1628 is H-F Specialist

The new RCA-1628 triode is a general-purpose transmitting tube for use as an oscillator, r-f power amplifier, and frequency multiplier at the ultra-high frequencies. It is capable of running at maximum ratings at frequencies *as high as 500 Mc* and at reduced ratings as high as 675 Mc! Outstanding among the features of this triode is its double-helical, thoriated-tungsten filament which is center-tapped within the tube. The center tap is brought out of the bulb to a separate lead. By connecting all three filament leads in parallel

(*Continued on page 3, column 1*)

ETHER BUSTER USES RCA-806



W2HNP of Roselle Park, New Jersey, rates a fiver for this fine photo. Tube line-up consists of an RCA-6L6 crystal oscillator, RCA-809 buffer amplifier, and an RCA-806 final with the famous Enclosed Tantalum Anode. Says W2HNP, "the 806 is working swell on all bands—operates on both phone and c.w. with between 400 to 600 watts input." More power to you, Om—if you need it!!

STATION LOG PADS AVAILABLE THROUGH YOUR DISTRIBUTOR

Well layed-out Sheets Make Logging a Pleasure

The RCA Log Sheets, now carried by your power tube distributor, are going a long way toward taking the drudgery out of station operation "bookkeeping." Designed by amateurs for amateurs, these 8½″ x 11″ sheets are laid out in such a manner that entries can be logged from left to right—in just the order that QSO procedure takes place. The top of each sheet provides itemized space for the required entry of your station call, address, name, and the sheet number. The QSO items from left to right are: Station, Worked or Called, Time (begun/ended), RST (his/mine), Frequency or Dial Degrees (his/mine), Final Stage Input Watts, and a 3⅝″-space for the Date, Type of Emission, QTH, Remarks, etc., items. There is plenty of room on the sheet to write without cramping.

An unusual feature of the log pages is their right-hand perforations for fitting into three-ring binders. When the binder is opened, this places the sheet in use on the left side of the binder, while the blank side of the next sheet falls on the right side of the binder. Thus, each sheet serves a double purpose by providing a handy note page for jotting down the usual informal QSO comments, drawing sketches, and "doodling."

RCA Log Sheets come in pads of 25 each. One pad provides space for 725 entries. See your transmitting tube distributor for your supply.

AR-77 Features High Signal-To-Noise Ratio

(*Continued from page 1, column 2*)

have to compete with receiver noise background. To increase receiver sensitivity without keeping set noise to a minimum would not give better reception. But, to increase the ratio between developed signal voltage and noise voltage does count —and plenty, too. The higher this ratio is made the better is signal intelligibility.

Let us take a look at the physics of noise developed in receiver circuits and see how RCA engineers handled the problem in the AR-77.

R-F Circuits Have High L/C Ratio

The primary source of circuit noise ("built-in" noise) is caused by thermal agitation, or state of molecular unrest, in the resonant circuits of the r-f preselector stage. The same phenomena also exists in the antenna but here its effects are negligible. Thermal agitation voltage in the first tuned circuit increases as the *square root* of the impedance. The signal voltage developed across an impedance varies directly as the impedance. By increasing the input-resonant impedance, it is possible to raise the signal-to-noise ratio. Low-loss circuits having high inductance-to-capacity ratios raise the resonant circuit impedance. The AR-77 takes this requirement into account by using specially designed low-loss tuning inductances having POLYSTYRENE insulation and magnetite cores.

Another design problem confronting the receiver engineer is the LC ratio of the tuned circuits. This ratio is determined by the tuning range of the receiver and by the practical necessity of meeting customer requirements for high performance with general frequency coverage.

With these factors in mind, the logical choice is to design the circuits to have as high an LC ratio as is practical for each frequency range

(*Continued on page 3, column 2*)

30 EVERY 60 MINUTES

RCA-811's and 812's are sealed and pumped free of air in a spectacular run through the famous SEALEX machine. More adept than human hands, more accurate in vacuum control than the element of human judgment, this machine produces finished tubes that are uniform both in characteristics and in quality.

811's and 812's pass through the sealing-exhausting process in 16 steps. Air is removed from the tubes by means of two mechanical pumps, followed by four mercury pumps and by another mechanical pump. Occluded gas from the glass parts of the tube is removed by flames which blast the bulbs to near melting point. Occluded gas from the metal parts is removed by heating them to incandescence in terrific r-f fields. Finally, the tube "getter" is flashed to absorb, in conjunction with the famous Zirconium-Coated Anode, any last trace of gas.

New Bottles Put Out Real Power On U.H.F.

(*Continued from page 2, column 1*)

through r-f by-pass condensers, it is practical to minimize the effect of filament-lead inductance. Important also are the double grid and plate leads which are brought out of the bulb through individual seals. In amplifier service, the double leads facilitate neutralization by eliminating common impedances between tank and neutralizing circuits within the tube. In oscillator service, it is desirable to connect these leads in parallel to reduce their respective inductances. RCA-1628 utilizes a closely spaced grid and plate construction. This design decreases electron transit-time between the filament and plate and thereby improves the efficiency of the tube at the ultra-high frequencies. The grid and plate are made of tantalum.

Maximum CCS ratings of the 1628 in class C telegraph service are: D-c plate voltage, 1000 volts; d-c plate current, 60 ma.; plate input, 50 watts; and plate dissipation, 40 watts. Typical driving power at a plate voltage of 1000 volts is approximately 1.7 watts; typical power output, approximately 35 watts. Filament rating of the tube is 3.5 volts at 3.25 amperes.

The RCA-829 and RCA-1628 are now available to experimenters and amateurs through RCA Tube Distributors. Net price of the 829 is $19.50; net price of the 1628 is $32.00. For additional technical information on these two ultra-modern transmitting tubes, write to the Commercial Engineering Section, RCA Radiotron Division, Harrison, New Jersey.

Prices Greatly Reduced

(*Continued from page 1, column 3*)

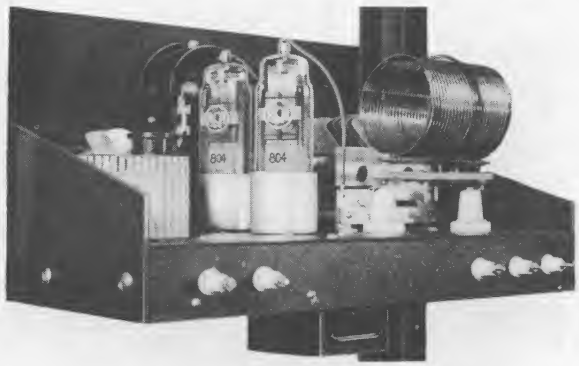
oscillator, RCA-813 makes an efficient one-tube transmitter of relatively high power (see December, 1938 Ham Tips).

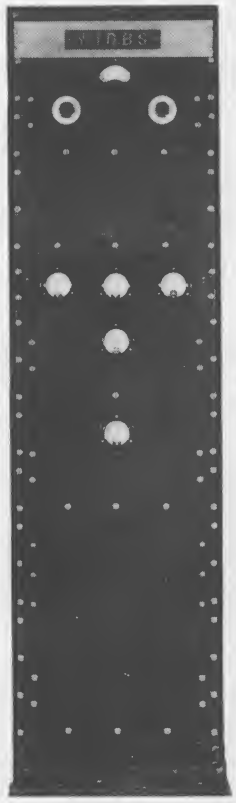
RCA-832 is the tiny push-pull beam power tube that takes up to 36 watts input at 2 meters. This tube also requires no neutralization. R-f drive for the 832 is less than 0.2 watt at a plate voltage of 400 volts.

RCA-1624 is a metal type beam power transmitting tube capable of taking 54 watts input up to 60 Mc. It is designed with a fast-heating. filament that makes it ideal for use as an a-f or r-f amplifier, modulator, frequency multiplier, or oscillator in equipment where quick off-on operation is essential.

Take advantage of the new prices on these types to build that unusual rig you have been planning.

TWO RCA-804's FEATURE FLEXIBILITY, VERSATILITY





W1DBS of New Britain, Connecticut, well deserves the $5.00 in the mail for him for these excellent views. His rig uses an RCA-89 crystal oscillator, an RCA-807 buffer amplifier, and a pair of RCA-804's in push-pull in the final. No neutralizing headaches to worry about in this job. The transmitter works five bands (160, 80, 40, 20, 10) and uses both c.w. and phone. On phone, the 804's are plate-madulated with a pair of RCA-801-A/801's in class B. "I use RCA tubes throughaut," says W1DBS. We're praud to knaw that he does.

AR-77 Features High Signal-to-Noise Ratio

(*Continued from page 2, column 4*)

and to be sure that each amateur band is completely covered with adequate overlap between ranges. The harmonic relationship of the amateur bands, along with the included broadcast band, requires a total of six tuning ranges—*and the AR-77 has this number of ranges.* It is also of paramount importance to use extremely low-loss insulating material for the coil forms, tuning condenser, and r-f trimmers. In the AR-77, POLYSTYRENE insulation is used for the two highest range coils and high grade bakelite for the lower frequency ranges. Ceramic insulation is used in the tuning condensers, trimmers, and r-f tube sockets as well as in the range switch. Furthermore, it is essential to consider the problem of signal transfer from antenna to receiver. The AR-77 antenna coupling coil is arranged to give maximum signal voltage transfer from antenna to the first tuned circuit. The antenna trimmer allows the first r-f circuit to be peak-tuned at all times—thereby maintaining the maximum Signal/Noise ratio on whatever frequency the receiver is tuned.

The cumulative effects of all these careful design considerations in the AR-77 makes its ratio of weak signal voltage to thermal agitation voltage unusually high as compared with previous designs.

DID YOU KNOW THAT—

—the air pressure within an average radio tube envelope is anly one one hundred millionth that of atmospheric pressure at sea level?

—some receiving tubes contain as many parts as a fine 17-jeweled watch?

AR-77 Minimizes "Shot Effect"

Circuit noise may also be produced by the flow of the electron stream from tube cathode to plate. Extensive studies show that for two small intervals of time, the quantity of electrons flowing between cathode and plate is not uniform. This irregularity occurs throughout the radio spectrum and means that wherever the receiver is tuned the noise or hiss caused by this effect is present. The phenomenon is known as "shot effect." Factors controlling "shot effect" are plate current and band width. The effect varies as the square root of each of these factors.

The AR-77 minimizes "shot effect" by establishing the plate current of the r-f tubes as low as will maintain their transconductance and give maximum gain.

The band-width factor is controlled by the overall r-f selectivity of the AR-77 itself. It is interesting to note at this point that the first step in the crystal-filter circuit narrows the band width and greatly reduces the noise from "shot effect" without materially affecting the intelligibility of voice-modulated signals and without producing excessive high-frequency, sideband reception.

The net result of including these considerations in the design of the AR-77 makes it a "natural" for pulling in more signals than ever before possible, particularly those weak ones down around a microvolt or less.

2 RCA-811's DELIVER 225 WATTS OF A. F.

This photograph is but a sample of what you receive when you ask for the Special Ham Bulletin cavering the design of the 811 class B modulator and its associated power supply. Be sure to write for your free copy.

RCA-828 BEAM TUBE TAKES 270 WATTS (ICAS) ON C.W.

Max. Plate Input Is 200 Watts for Plate Modulation

The multi-electrode transmitting beam power tube RCA-828, which was recently announced to radio amateurs, is the logical answer for those who desire the utmost in efficiency for medium-powered rigs. In r-f services it will give full output with very low driving power. Consequently, fewer driver stages are required. Almost any small tube will serve as a driver. A Tritet 6L6 or 6V6-G oscillator will excite the 828 even when frequency doubling is used in the oscillator plate circuit.

The 828 is ideal for use in transmitters where quick band change without neutralizing adjustments is desired. It will take maximum ratings at frequencies as high as 30 Mc and reduced ratings up to 75 Mc. RCA-828 is also well-suited for use as a frequency multiplier, oscillator, class AB_1 modulator, and grid- or plate-modulated r-f power amplifier. The tube is equipped with the new "MICANOL" base. A circuit showing application of the 828 in c-w service is shown below. Data for class C telegraphy are listed on this page. Amateur net price of the 828 is $17.50. For additional information on this tube, write to the Commercial Engineering Section, RCA Manufacturing Company, Harrison, N. J.

EASY TO DRIVE

High power sensitivity and a power output of 200 watts make the RCA-828 one of the most popular Beam Power tubes ever introduced for medium-power transmitters.

HAMS PLEASE NOTE!

WIN $5.00!

Does Your Transmitter Use RCA Tubes Throughout?

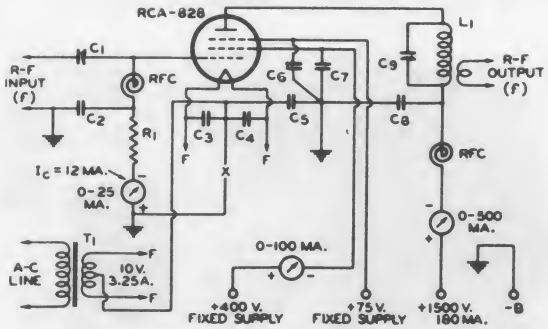
If so, send us a photograph and a brief description of it. Photos of final amplifier stages are also suitable. We should like to publish one or more such photos in each issue of HAM TIPS. Those published win $5.00 cash. "Commercial type" rigs are not given preference—what have you?

(This offer good in Western Hemisphere, Hawaii, and the Philippine Islands.)

RCA-828

TENTATIVE RATINGS

FILAMENT VOLTAGE (A.C. or D.C.)		10.0	Volts
FILAMENT CURRENT		3.25	Amperes
DIRECT INTERELECTRODE CAPACITANCES:			
Grid-Plate (with external shield)		0.05 *max.*	μμf
Input		13.5	μμf
Output		14.5	μμf
As R-F Power Amplifier and Oscillator—Class C Telegraphy			
Key-down conditions per tube without modulation			
	(*CCS*)	(*ICAS*)	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
D-C SUPPRESSOR VOLTAGE	100 *max.*	100 *max.*	Volts
D-C SCREEN VOLTAGE	400 *max.*	400 *max.*	Volts
D-C GRID VOLTAGE	−300 *max.*	−300 *max.*	Volts
D-C PLATE CURRENT	160 *max.*	180 *max.*	Ma.
D-C GRID CURRENT	15 *max.*	15 *max.*	Ma.
PLATE INPUT	200 *max.*	270 *max.*	Watts
SUPPRESSOR INPUT	5 *max.*	5 *max.*	Watts
SCREEN INPUT	16 *max.*	16 *max.*	Watts
PLATE DISSIPATION	70 *max.*	80 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	1250	1500	Volts
D-C Suppressor Voltage	75	75	Volts
D-C Screen Voltage	400	400	Volts
D-C Grid Voltage:			
From a fixed supply of	−95	−100	Volts
From a grid resistor of	7900	8300	Ohms
or from a cathode resistor of	415	430	Ohms
Peak R-F Grid Voltage	195	205	Volts
D-C Plate Current	160	180	Ma.
D-C Suppressor Current	22	14	Ma.
D-C Screen Current	35	28	Ma.
D-C Grid Current (Approx.)	12	12	Ma.
Driving Power (Approx.)	2.1	2.2	Watts
Power Output (Approx.)	150	200	Watts



RCA-828 R-F POWER AMPLIFIER

Power Output Approximately 200 Watts for Class C Telegraph Service

C_1 = 50 μμf midget.
C_2 C_3 C_4 = 0.005 μf, mica.
C_5 C_8 = 0.002 μf, mica, 5000 v.
C_6 C_7 = 0.01 μf, mica.
C_9 = 1.5 μμf/meter*.
R_1 = 8300 ohms, 4 watts.
L_1 = Tune to frequency "f".
RFC = R-f choke.
T_1 = Filament transformer, 2000-v. insulation.
f = Operating frequency.
x = Insert keying relay here.

* Capacitance in actual use. Minimum air-gap should be 0.07".
NOTE: Power output of driver stage should be about 5 watts.

POWER ON 1½ METERS

This is a high-frequency test oscillator in action. It uses two RCA-887's—small, water-cooled triodes built particularly for use at the ultra-high frequencies and which measure only 7⅛" high. The oscillator in this picture is capable of producing 1100 watts of useful power in the output circuit—at 100 Mc! Photograph shows a part of the output energy being dissipated in a standing arc. The discharge is so intense that small particles of molten metal are being expelled from the contact wire. Paths of these particles are indicated by streaks surrounding the discharge.

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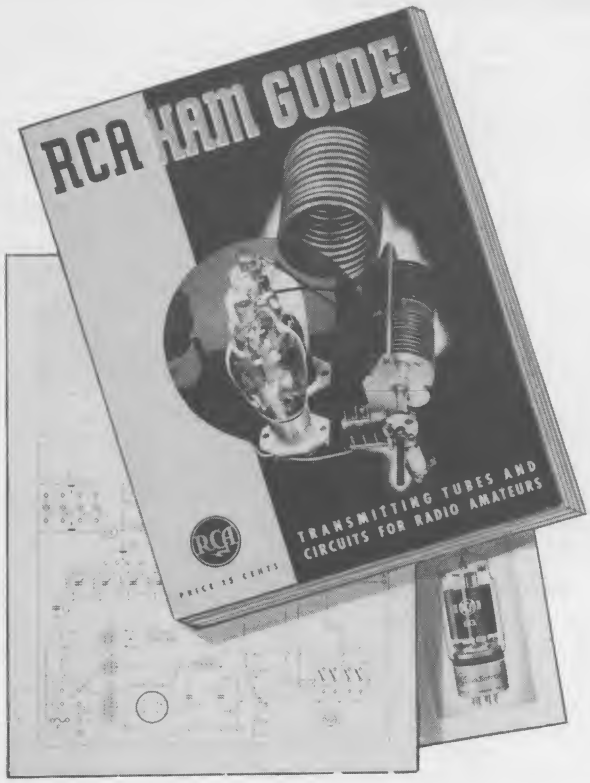
Form 1P2010 Printed in U.S.A.

HAM TIPS *from* RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 3—No. 3 CAMDEN, N. J. JUNE-JULY, 1940

NEW RCA-1847 MAKES HAM TELEVISION PRACTICAL



NEW RCA HAM GUIDE RECEIVES WIDE PRAISE

Contains 48 Illustrated Pages of Xmtg-Tube Circuits and Data

Here is the transmitting guide amateurs from coast-to coast are acclaiming! Written specifically for the *amateur*, this new book contains forty-eight pages of authoritative technical data on RCA's most popular amateur tubes such as the 802, 806, 807, 808, 809, 810, 811, 812, 828, etc. Carefully proved circuits are shown with each tube in order to utilize the tube to its best advantage. Six complete pages are devoted to the general design and operation of amateur transmitters.

Two complete transmitters are described in detail from mike- and key-to-tank. These descriptions include pictures and complete circuits. One transmitter is a complete 5-band cathode-modulated 'phone/c-w rig working from 10 to 160 meters. Power input is 220 watts on 'phone and 450 watts on c.w. The other transmitter is a plate-modulated outfit with 310 watts input on 'phone and 450 watts on c.w. It also operates from 10 to 160 meters. The design of these transmitters is simple and straightforward.

All in all, this 8½" x 11" book contains over 70 illustrations and more than 30 up-to-the-minute transmitting circuits. It is easy to read and completely different in style. You can obtain a copy of the RCA HAM GUIDE from your RCA Transmitting Tube Distributor, or by sending 15 cents direct to the Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, N. J.

LOW-PRICED ICONOSCOPE OPENS NEW FIELDS FOR AMATEUR PIONEERS

Acclaimed at Chicago Parts Show where it was demonstrated in typical equipment

The fond dream of transmitting and receiving pictures via Ham Television on Ham bands is now a reality.

June 11 to 14 were banner days for Ham Television when, for the first time, RCA engineers demonstrated really practical amateur television transmission and reception at the Chicago Radio Parts Show. The equipment used will be described. Running continuously for 10 to 12 hours at a stretch under the call of W10XEL, this gear clearly demonstrated to hundreds of enthusiastic amateurs, engineers, dealers, and distributors the practicability of good quality television communication with simplified and economical apparatus. Demonstrations were conducted on the 12th floor of the Blackstone Hotel overlooking Lake Michigan where it was possible not only to televise indoor subjects but also to pick up panoramic scenes from off the lake and along the boulevard as well. Even skeptics and those "in the know" on television were frankly amazed at the faithful reproduction and stability of the pictures along with the simplicity of the complete equipment.

"MINI-IKE" PAVES THE WAY

Amateur Iconoscope RCA-1847 is the famous television camera "eye" that changes light variations into electrical variations. It is 7⅝" long and has a 2-inch face on which the images are focused. Amateur net price for the 1847 is only $24.50. This pick-up tube—engineered by the same men who produced the larger iconoscopes—completes the tube line required to get started in Ham Television.

Small Brother to Big "Ikes"

The advent of the new amateur Iconoscope RCA-1847 now makes it possible to construct at a cost within the price range of a present-day amateur transmitter a complete television system. This "Mini-Ike" is a smaller, much simplified version of the larger and more familiar Iconoscope Television camera tubes used in large Television studio cameras. It is 7⅝" long, has a 2-inch face, and is capable of producing a clear, 120-line, 30-frame-per-second picture that is well suited for transmission in the 2½- or 1¼- meter amateur band. RCA-1847 operates at relatively low voltage, employs inexpensive electrostatic deflection circuits, does not require keystone correcting circuits, and can utilize low-cost, short-focal-length lenses. The tube is now available through RCA Transmitting Tube Distributors at the amateur net price of $24.50.

How the 1847 Works

The principal parts of the 1847 are its mosaic, signal electrode, collector, and electron gun. The position of these parts in the 1847 is illustrated

(*Continued on page 2, column 1*)

Copyright 1940, RCA Manufacturing Co., Inc.

HAM TIPS from RCA

New RCA-1847 Makes Ham Television Practical

(*Continued from page 1, column 4*)

in the diagram below. The mosaic consists of a large number of small photosensitive particles deposited on one face of a transparent sheet of insulating material. The particles are spaced a very small distance apart so as to be insulated from each other. On the opposite face of the insulating sheet is the signal electrode, a transparent conductive film. This electrode makes contact with a band of conductive material on the inner surface of the bulb. Another band of conductive material is mounted on the external surface of the bulb, directly over the internal band. The capacitance between the two bands, in series with the capacitance between the signal electrode and mosaic, provides coupling between the mosaic and the signal-electrode terminal.

In the operation of the 1847, an image of a scene is focused on the mosaic and the beam of electrons provided by the electron gun is made to scan the image. As the beam moves over the image, there is generated across the signal-electrode load resistor a voltage whose magnitude at any instant depends on the image brightness at the point where the beam is striking at that instant. This voltage is used as the video signal for Television transmission of the scene viewed by the Iconoscope.

How Much Illumination is Needed?

The lighting equipment required for operation of the 1847 can be simple. Inside-silvered lamps are a convenient form of light source. When an f:2.3 lens is used, adequate lighting of photographs, drawings and other still subjects can be provided by a single 200-watt, inside-silvered, spot-light bulb. A value of 1.5 focal lengths is generally suitable for the distance from the lens to the subject. For this spacing, the illumination on the subject should be not less than about 3,000 foot candles.* The 200-watt bulb described above can provide this illumination on the subject when the bulb is about 15 inches from the subject. For televising "living talent" it is generally desirable to have a larger spacing between the lens and subject so that the lens will have a larger field of view. When this spacing is approximately 10 focal lengths or greater, the necessary illumination on the subject is 1500 foot candles.

Gear Uses B. C. L. Parts

Major equipment required for the operation of an amateur television system includes a television receiver, a pick-up camera and monitor unit, and an ultra-high-frequency transmitter. Such equipment has been built in our laboratory by our engineers and described in detail in a series of articles recently published in the May, June and July issues of QST. A feature of all of this apparatus is that *standard broadcast receiver parts are used almost exclusively throughout the circuits.*

Receiver is Straightforward Super

The Television receiver itself is a superheterodyne and is designed to cover the 112-116 Mc amateur Television band. The output of the receiver terminates in a 3-inch Kinescope, type 3AP4/906-P4, which produces bright pictures in black and white. The tube line-up is as follows: A 956 Acorn type pentode is used as the first detector with a 6J5 oscillator. There are two i-f's using 6AC7/1852's. The second detector utilizes one diode section of a 6H6 and is followed by one 6AC7/1852 video stage. The other half of the 6H6 is used as a detector for synchronizing purposes only. This diode feeds a 6SC7 double triode, the first half of which is used as amplifier and the second half as sync separator. Multivibrators containing one 6SC7 each are the scanning oscillators. The Kinescope anode potential of 1500 volts is obtained inexpensively from a small receiver power transformer with two 5U4-G's in a voltage-doubling circuit. The remainder of the tubes are operated from a low-voltage 5Y3-G supply.

*A foot candle is the amount of illumination produced by a standard candle at a distance of one foot.

Modulator Contains "Ike"

The modulator furnishes the complete television signal for modulating the r-f amplifier of the television transmitter. It consists of the RCA-1847 Iconoscope, a video amplifier capable of raising the initial signal to a level sufficient for modulation, a monitor Kinescope, scanning circuits for the Iconoscope and monitor, blanking and synchronizing signal generators, a high-voltage supply for the Iconoscope and monitor, and a low-voltage regulated supply. The scanning frequencies are 30 frames per second and 3600 lines per second. The video channel width thus required is about 200 kc., which, of course, means 400 kc. on the air with double sideband modulation. Inasmuch as the entire 2½-meter amateur band (for which this equipment is intended) is only 4000 kc. wide, it is apparent that the channel width must be restricted to the minimum value needed for reasonable definition.

Xmtr Uses Twin Beam 829

The r-f transmitter proper is of simple and straightforward design. It has no frills or doodads. Although the rig employs a 40-meter crystal, only four r-f stages are required. The tube line-up begins with a 6L6 Tri-tet crystal oscillator, followed by a 6L6 5-meter doubler and then a 6L6 2½-meter doubler. Output from the last doubler is sufficient to drive fully an 829 twin beam power tube as a straight push-pull final amplifier on 2½ meters. This transmitter is capable of kicking out a carrier of 20 watts or better with video grid modulation and, incidentally, makes an excellent 'phone transmitter having considerably greater carrier output when used with conventional plate modulation.

Actual field tests conducted with this television gear have been made with the receiver located about 1½ miles from the transmitter. It is anticipated that distances of 10 to 15 miles can easily be covered with this same equipment.

We Scan the Crystal Ball

Television provides the next major development of amateur radio and once again the Ham is in an ideal position to go places. In this new art, amateur Television provides rich opportunity to gain new experience in circuit applications and to work with the fascinating principles of lighting, photography and optics—all thrown in one. For those who have felt that amateur radio is growing dull, here is the answer.

A new booklet, just off the press, contains complete data on how actually to build the complete Television station described in these columns. Get a copy from your nearest RCA Transmitting Tube Distributor, or write to the RCA Manufacturing Company, Inc., Commercial Engineering Section, Harrison, New Jersey.

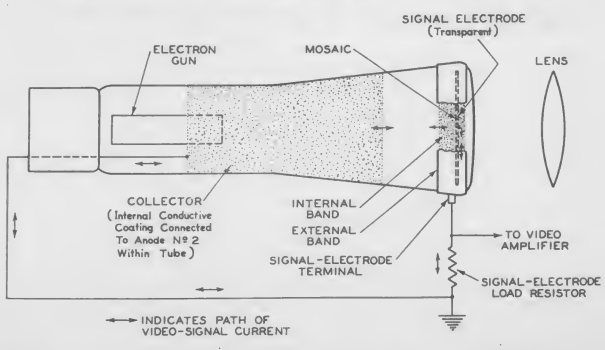
"CALLING CQ-VIDEO"

This is a complete Ham Television station. It was constructed to illustrate the practicability of radio amateur Television transmission and reception on 2½ meters. Demonstrated in actual operation, this equipment was hit of the Chicago Radio Parts Show. Most amateurs already have many of the required components. But even though you start from "scratch," it is possible to duplicate this system for no more than the cost of an ordinary medium-power transmitter.

THORIATED-TUNGSTEN FILAMENTS REVIVED

Thoriated-tungsten filaments of RCA transmitting tubes possess the capability, in many cases, of being reactivated after their emission has dropped off as a result of temporary tube overloads. The reactivation treatment is not 100 per cent effective but is worth trying when your hopes for saving "low" tubes have faded. The reactivation schedule is as follows: Operate the filament at rated voltage for 10 minutes or more *without* voltage applied to any of the other tube electrodes. The process may be accelerated by raising the filament voltage above its rated value by a small amount for a few minutes. The maximum voltage that should be used is 7.5 volts for 6.3-volt types, 9 volts for 7.5-volt types, 12 volts for 10-volt types, and 13 volts for 11-volt types.

FUNCTIONAL DIAGRAM OF THE 1847 MINI-IKE



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Form IG2481

Printed in U. S. A.

Ham Tips from RCA

Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 4 — No. 1 CAMDEN, N. J. JANUARY, 1941

NEW RCA-866-A/866 HAS RADICALLY DIFFERENT FILAMENT

"SWEEPSTAKES" WINNERS AGAIN USE RCA TRANSMITTING TUBES

W2IOP Clinches Prize with 814; W6ITH Does it with 806's

We are mighty proud to remind you that the winners and the high-scoring stations of the Tenth A.R.R.L. Sweepstakes again used RCA Transmitting Tubes. Topping even the Ninth SS scores, when W3BES won hands down with a pair of RCA-809's, comes Mr. Larry LeKashman, of W2IOP, who worked 646 stations in 63 sections on c.w. and knocked off the terrific high score of 101,115. Then, there is Mr. D. Reginald Tibbetts, of famous W6ITH, who broke all records on phone by working 449 stations in 62 sections. We doff our toppers to you, gentlemen. You have done a swell job.

What They Used

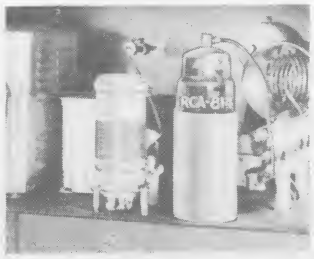
W2IOP's layout consisted of a Meissner Signal Shifter driving one RCA-814 Beam Power Amplifier. This tube, as you know, has an input rating of 225 watts, ICAS. With 7.5 watts output from the Signal Shifter, the greatest problem was to avoid over-exciting the 814. Larry says—"and as a driver, the 814 is capable of over-driving a one k-w amplifier 250%!" In W2IOP's latest rig Signal Shifter-814 arrangement is being employed to run a pair of RCA-813's in push-pull with 750 watts input.

W6ITH uses four separate push-pull RCA-806 finals—one amplifier for each of the four phone bands from 10 to 160 meters. Except for tank-circuit constants, the finals are all identical in construction. The all-band exciter for these finals uses a 6C5-6L6G-807 line-up. On 10 meters, this exciter drives an intermediate buffer using an RCA-808 triode. The 808 in turn kicks the push-pull 806 stage. On 20, 75, and 160 meters the exciter drives an RCA-828 Beam Power Amplifier which in turn pushes the p-p 806's. All four finals are modulated by a pair of RCA-810's in class B. The three power supplies employ RCA-866's and RCA-866-A's. The bias supply uses an RCA-83v.

LAST WORD ON PHOTOTUBES

In sound-film reproduction, color discriminating devices, light-measuring indicators, automatic counters, displays, etc., Phototubes play paramount roles. The new RCA Phototube 16-page booklet covers these applications, describes RCA's complete line of light-sensitive tubes. See your Transmitting Tube Distributor or write the Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, N. J. for your copy.

FINALS IN THE HALL OF FAME



LEFT: W6ITH, top voice man, has a power amplifier that is a symbol of symmetry. Note that corresponding plate and grid leads are identical in length and as short as is mechanically possible.
RIGHT: W2IOP's layout, using a single 814, pulled in the biggest score for a single operator in history. 95% of W2IOP's 40 tubes are RCA!

IMPROVED MERCURY-VAPOR RECTIFIER SUPERSEDES FORMER 866-A AND 866

New Rectifier Has High Ratings, Greater Life, and Tremendous Reserve of Filament Emission

866-A/866 Filament

Here is news that IS news! RCA engineers have just completed the design of a low-cost deluxe type half-wave, mercury-vapor rectifier tube known as the RCA-866-A/866 that bids fair to making rectifier history. Strikingly different in construction, this tube has exceptional life and a tremendous reserve of emission that beats anything in the 866 and the 866-A class.

The RCA-866-A/866 supersedes types 866-A and 866 and may be used in equipment designed for the former types. It combines the ability of the 866-A to withstand high peak inverse voltages with the ability of the 866 to conduct at low plate voltage . . . at a plus performance beyond any RCA rectifier type ever offered. Thus, at the maximum peak inverse voltage rating of 10,000 volts and a maximum peak plate current rating of 1 ampere per tube, two 866-A/866's operating in a full-wave rectifier circuit are capable of delivering to the input of a choke-input type filter a rectified voltage of 3,180 volts at 500 milliamperes with good regulation and with exceptional life.

Filament is Key to Long Life

Secret of the 866-A/866 is its improved edgewise-wound coated ribbon filament which is helical in shape and crimped. This design has great mechanical strength and provides more cathode area for the same filament power rating. And above all,

(Continued on page 2, column 1)

STANDS THE GAFF

Long life, enormous reserve of filament emission, ability to withstand a peak inverse voltage of 10,000 volts, 1000 ma. peak plate-current rating, conductivity at low plate voltage . . . RCA-866-A/866 has these all.

DID YOU KNOW THAT . . .

more RCA-807's and RCA-809's were used by the top flight Tenth National Sweepstakes Contestants last year than any other transmitting tube type?

HAM GUIDE, HAM GUIDE! WHO HAS THE HAM GUIDE?

W3IEM Solves the Problem

Dear Sirs:

Attention: "Ham Tips" Editor.

Several months ago I purchased from you an RCA Ham Guide, with which I was well pleased. Notice that I say "*was*" well pleased. That is because I have seen very, very little of it since I first showed it to my friends. As a matter of fact, I have not seen it for several weeks and believe me, I really miss it! It keeps me so busy loaning it out that I have decided to buy another one for myself and let the other fellows fight over the one that formerly belonged to me.

Seriously, though, I have found the RCA Ham Guide very useful around the shack in more ways than one. I particularly like the useful diagrams shown with each tube description.

Sincerely,
JOHN E. CANN,
W3IEM.

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New RCA-866-A/866 has Radically Different Filament

(*Continued from page 1, column 4*)

the filament is made of a new alloy material that, in combination with the active surface coating, possesses great electron-emitting capabilities and has improved life characteristics head and shoulders above ordinary 866 and 866-A types. The filament of the 866-A/866 is contained within a shield which permits more efficient utilization of filament heating energy, thus allowing more filament area for a given number of watts. The shield enables the tube to start on much lower voltage than with the former 866-A.

Important among the features of the new RCA-866-A/866 is its new dome type bulb with its added mechanical strength feature, and the large external ceramic insulator positioned under the plate cap. This construction greatly minimizes corona discharge emanating from the edge of the metal cap, which in turn alleviates the danger of bulb cracks caused by electrolysis of the glass.

Applications for the 866-A/866

Rectifier circuits for use with the RCA-866-A/866 are shown in Figs. 1

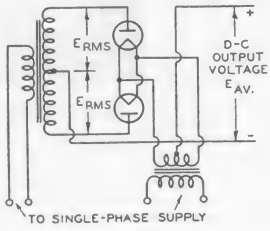


Fig. 1

to 4. Fig. 1 is the widely used single-phase, full-wave rectifier. Fig. 2 shows a single-phase bridge circuit employing two 866-A/866's in series on each side of a single-phase transformer secondary. This circuit is capable of giving twice the d-c output voltage of Fig. 1, for the same total transformer voltage and d-c output current. (Note: When using a bridge circuit, be sure that the load current is not in excess of the power rating of the transformer.) Fig. 3 shows a 3-phase, half-wave circuit using three RCA-866-A/866's. In this circuit, each tube conducts for only one-third cycle and each 60-cycle period contains three rectified waves. Fig. 4 shows a 3-phase, full-wave bridge circuit employing six 866-A/866's. Two tubes are connected in series with each transformer leg. Like the bridge circuit of Fig. 2, this circuit will give twice the d-c output voltage of the half-wave circuit in Fig. 3. In Fig. 4, each 60-cycle period contains six rectified waves.

A summary of the approximate results which can be obtained with the use of the 866-A/866 and similar mercury-vapor types is shown in Table 1. The table is based on sine-wave input and the use of a suitable choke preceding any condenser in the filter circuit. It does not, of course, take into account the voltage drop in the power transformer, the rectifier tubes, nor the filter-choke windings under load.

How the Table Works

Table 1 is a handy reference for rectifier problems. For example, if either one of the three voltages, Peak Inverse Voltage (E_{INV}), D-C Output Voltage to Filter (E_{AV}), or Transformer Secondary Voltage (E_{RMS}) are known, the other two voltages may be calculated by simple multiplication.

Suppose a single-phase transformer secondary measures 2000 volts, E_{RMS}, from center-tap to outside terminal (4000 volts, total). What will be the d-c output from two half-wave mercury-vapor rectifier tubes in a full-wave circuit and what will be the maximum peak inverse voltage impressed on each tube? Table 1 shows that in a single-phase full-wave circuit employing two tubes E_{AV}=0.9 x

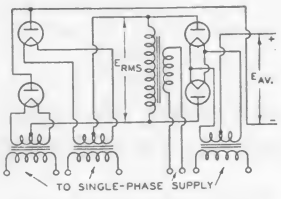


Fig. 2

E_{RMS}, which is 0.9 x 2000, or 1800 volts, d-c. In the same circuit, E_{INV}= 2.83 x E_{RMS}, which is 2.83 x 2000, or 5660 volts.

Let us approach the design of rectifiers from another angle. Suppose we wish to select a pair of rectifier tubes suitable for use in a single-phase full-wave power supply, the complete unit to deliver to the filter a total average current of 500 ma. at a maximum d-c voltage of 3000 volts. What maximum secondary voltage (E_{RMS}) should the transformer be designed to handle in order to deliver 3000 volts to the filter at maximum load current and what tubes will fill the bill?

First, determine the maximum peak inverse voltage which each rectifier tube must withstand. By reference to the relations shown for the single-phase, full-wave circuit Fig. 1 in Table 1, we find that the maximum

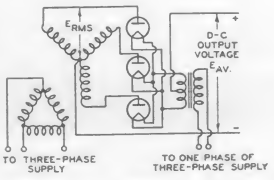


Fig. 3

peak inverse voltage corresponding to a d-c voltage of 3000 volts is 3.14 x 3000, or 9430 volts. Since two half-wave rectifiers are required in this service, each rectifier will only have to deliver 500/2, or 250 milliamperes. The rectifier tube meeting this voltage and current requirement is the 866-A/866, with its peak inverse voltage rating of 10,000 volts and its average plate current rating of 250 milliamperes. In order to deliver 3000 volts to the filter at maximum load, the transformer should be designed so that each half of the secondary will produce an E_{RMS} or 1.11 x 3000, or 3330 volts.

Parallel Connection Ups Power

Two or more 866-A/866's can be connected in parallel to give correspondingly increased output current over that obtainable with a single tube. A stabilizing resistor of 50 to 100 ohms should be connected in series with each plate lead in order that each tube will carry an equal share of the load. The value of the resistor will depend on the value of the plate current that passes through the rectifier. Low plate current requires a high value; high plate current, a low value. When the plates of 866-A/866's (or for that matter any other mercury-vapor rectifier) are connected in parallel, the corresponding filament leads should be similarly connected. Otherwise, the tube voltage drops may be considerably unbalanced and larger stabilizing resistors will be required.

RCA-866-A/866 fills a wide field of applications from low-voltage, medium-current requirements to the super-power requirements of big-time installations. This new rectifier tube is now available to experimenters and amateurs through RCA Transmitting Tube Distributors at the unusual amateur net price of $1.50. For additional technical information on 866-A/866's, write to the Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, N. J.

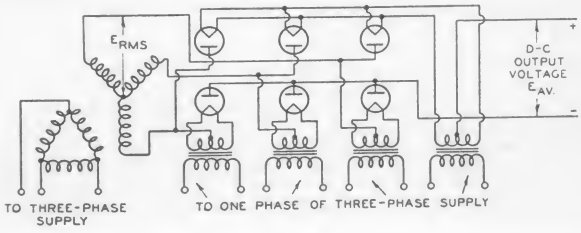
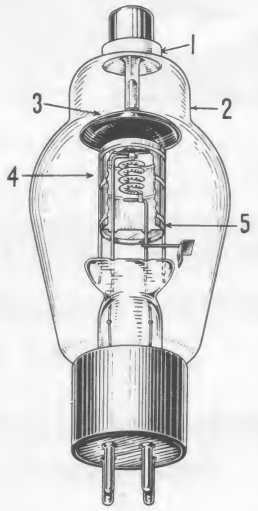


Fig. 4

STRUCTURE OF RCA-866-A/866



(1) Ceramic insulator to minimize corona discharge, (2) dome bulb and (3) low-hanging anode to minimize ionization in upper section of bulb, (4) edgewise wound filament for great emission, (5) shielded filament construction.

RATINGS FOR RCA-866-A/866

FILAMENT VOLTAGE (A.C.)	2.5	2.5	Volts
FILAMENT CURRENT	5.0	5.0	Amperes
PEAK INVERSE VOLTAGE*:			
(For supply frequencies up to 150 cycles)			
Cond. Mercury Temp. 25° to 60° C.	....	10000 *max.*	Volts
Cond. Mercury Temp. 25° to 70° C.	200 *max.*	....	Volts
(For supply frequencies up to 1000 cycles)			
Cond. Mercury Temp. 25° to 70° C.	....	5000 *max.*	Volts
PEAK PLATE CURRENT	2.0 *max.*	1.0 *max.*	Amperes
AVERAGE PLATE CURRENT	0.5 *max.*	0.25 *max.*	Ampere
TUBE VOLTAGE DROP (Approx.)	15	15	Volts

*Operation of tube at 40° ± 5° C. is recommended.

TABLE 1

Circuit	See Fig.	Transformer Secondary Voltage E_{RMS}	D-C Output Voltage to Filter E_{AV}.	Peak Inverse Voltage E_{INV}.	Max. Average Load Current Permitted
Single-Phase Full-Wave (2 Tubes)	1	(per tube) 0.353 x E_{INV}. or 1.11 x E_{AV}.	0.318 x E_{INV}. or 0.9 x E_{RMS}	3.14 x E_{AV}. or 2.83 x E_{RMS}	2 x {Max. Average Plate-Current Rating per Rectifier Tube
Single-Phase Full-Wave Bridge (4 Tubes)	2	(total) 0.706 x E_{INV}. or 1.11 x E_{AV}.	0.636 x E_{INV}. or 0.9 x E_{RMS}	1.57 x E_{AV}. or 1.41 x E_{RMS}	2 x {Max. Average Plate-Current Rating per Rectifier Tube
Three-Phase Half-Wave (3 Tubes)	3	(per leg) 0.408 x E_{INV}. or 0.855 x E_{AV}.	0.478 x E_{INV}. or 1.17 x E_{RMS}	2.09 x E_{AV}. or 2.45 x E_{RMS}	3 x {Max. Average Plate-Current Rating per Rectifier Tube
Three-Phase Full-Wave (6 Tubes)	4	(per leg) 0.408 x E_{INV}. or 0.428 x E_{AV}.	0.956 x E_{INV}. or 2.34 x E_{RMS}	1.05 x E_{AV}. or 2.45 x E_{RMS}	3 x {Max. Average Plate-Current Rating per Rectifier Tube

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation.

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HAM TIPS from RCA

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VOL. 4 — No. 2 CAMDEN, N. J. FEBRUARY-MARCH, 1941

NEW HIGH-POWER TRIODE HAS BROAD FIELD OF USES

RCA-8000 is Rated at 620 Watts Input (ICAS) for CW Service

RCA-8000 is the new outstanding high-power triode added to the line of famous RCA Air-cooled transmitting tubes. Special feature of the tube is its construction which provides high insulation resistance between electrodes. This design enables the tube to withstand high peak voltages.

Mu Lower Than 810

Similar in appearance to the popular 810, the 8000 also has a similar maximum plate dissipation of 150 watts (ICAS) but has a lower mu of 16.5. Grid-driving requirements also are lower than the 810. RCA-8000 is particularly suitable for use as an r-f amplifier and class B modulator. Because of its high perveance, it can be operated at high plate efficiency with low driving power and relatively low plate voltage. *Two 8000's in class C telegraph service (ICAS) will take a power input*

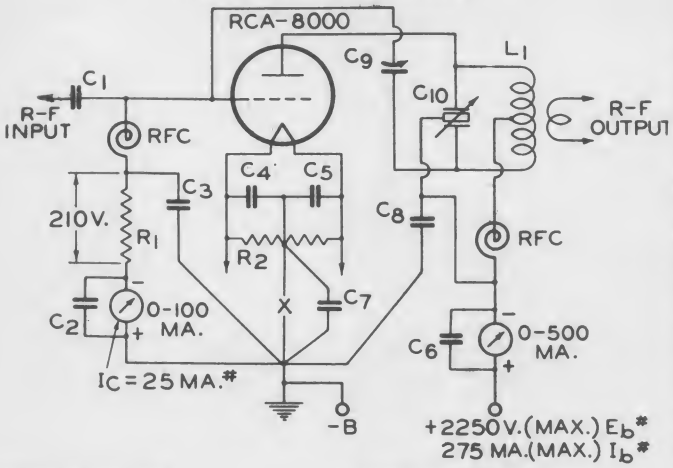
(*Continued on page 4, column 1*)

POWER PLUS

Rated at 275 ma. and 2250 volts (ICAS) and with internal construction designed for higher-than-ordinary voltages, RCA-8000 stands ready to take it in any field. Amateur Net Price is only $13.50.

R-F POWER AMPLIFIER USING RCA-8000

Power Output 475 Watts, ICAS



C_1=0.0005 μf, mica, 1500 v.
C_2 to C_6=0.002 μf, mica
C_7=0.002 μf, mica, 2500 v.
C_8=0.002 μf, mica, 5000 v.
C_9=4.8 μμf (approx.), 7500 v.
C_{10}=0.75 μμf/meter/section†
R_1=8400 ohms, 20 watts
R_2=50 ohms, c.t., wire-wound
L_1=Select for band desired
RFC=R-f choke
X=Insert keying relay here

† Approximate capacitance in actual use at resonance.

For ICAS plate-modulated telephony service, reduce E_b to 1800 v., I_b to 250 ma., and decrease I_c to 20 ma. The power output is approximately 335 watts.

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SIMPLE CURVES MAKE CORRECT RECTIFIER FILTER DESIGN EASY

Unique Method By RCA Engineers Safeguards Rectifier Tubes, Predetermines Ripple

Rectifier filters are often a neglected part of a transmitter—bogey-men of the shack. It isn't that there is a dearth of information on the subject of filters. Quite the reverse is true—and that is often the hitch. By the time a fellow has waded through the volumes of engineering treatises on filters, combed popular articles on LC ratios, peak currents, ripple voltages and swinging chokes, the chances are he will have given up in despair and reach once again for his old reliable "brute-force" smoother.

In the curves, page 2, RCA engineers have gone a long way toward taking the fuss and muss out of rectifier filter design problems. To use these curves, it is only necessary to decide how much ripple voltage you wish to tolerate in the output, then pick from the curve a suitable combination of choke and condenser values that will meet this requirement. The LC combination you chose automatically limits to a safe value the peak plate current and average plate current flowing through the rectifier tubes. Moreover, it pre-

(*Continued on page 3, column 1*)

DID YOU KNOW THAT . . .

The filaments of RCA battery-operated tubes are finer than a pin point? For example, filament diameter of the RCA-958 Acorn tube is approximately 0.001 inch—that of the 957 and 959 Acorns, only 0.0006 inch!

W3BKX/3 USING RCA TUBES WINS FIELD DAY CONTEST

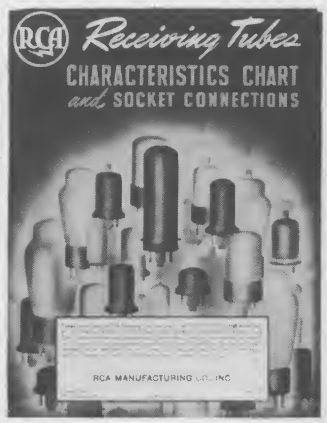
Frankford Radio Club Xmtrs Feature 807's and VR-150's

For the second consecutive issue of Ham Tips, we can boast with pardonable pride to the fact that the winner of major national contest used RCA tubes—and plenty of them. The Frankford Radio Club of Philadelphia, operating under the call of W3BKX/3 gathered in 8406 points with 601 contacts during the 1940 A.R.R.L. Field Day jamboree. This is a record if ever there was one. Congratulations, F. R. C. During the 26 hours of contest in which the seven stations of the club were on the air nearly continuously, every one of the 43 RCA tubes gave 100% uninterrupted service.

The tube line-ups in the seven transmitters at W3BKX/3 are straightforward. They signify that careful planning contributed in no

(*Continued on page 4, column 4*)

YOURS FOR THE ASKING



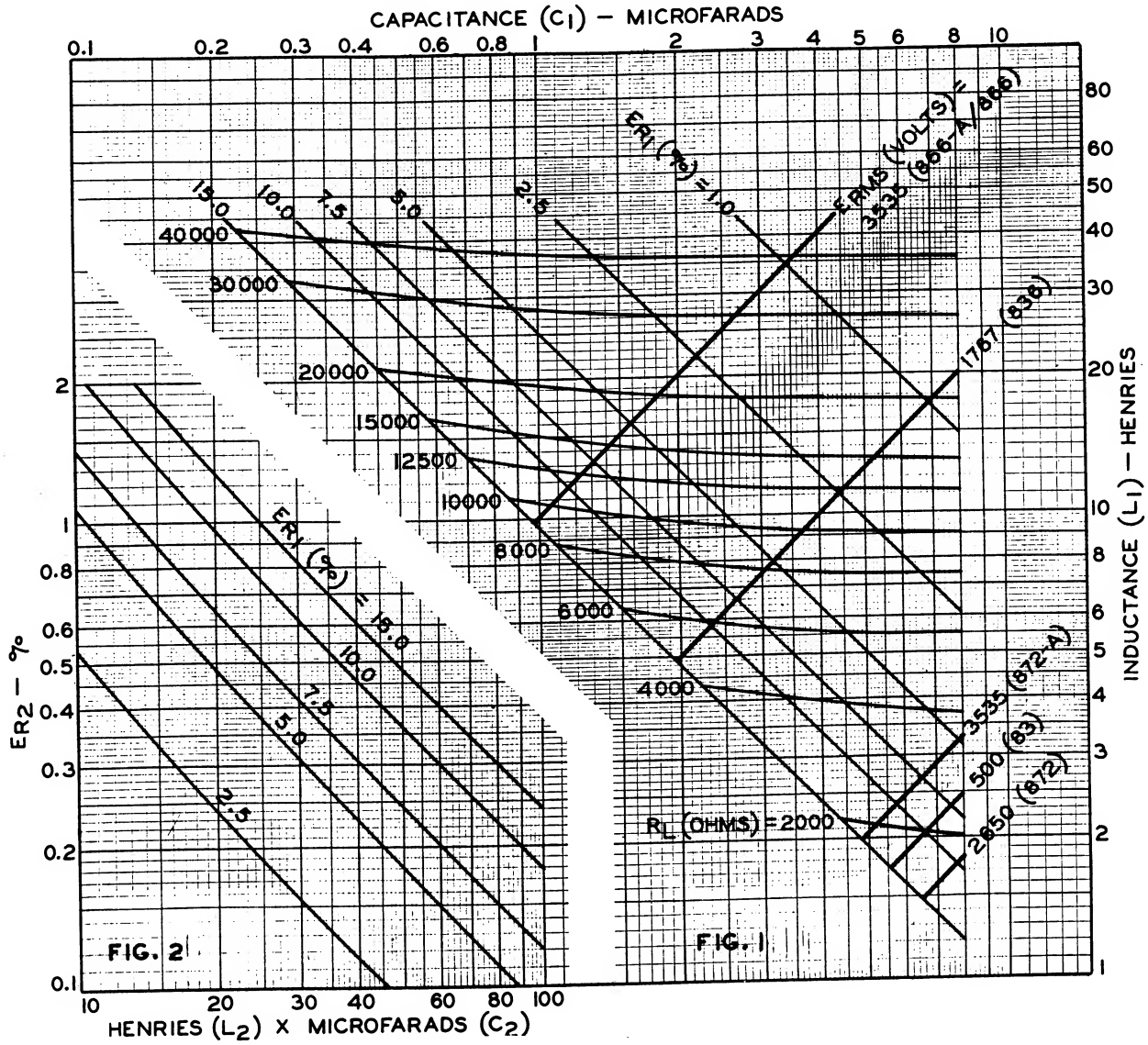
A brand new 16-page Receiving Tube Chart is now available for amateurs, servicemen, and engineers. This chart, known as the 1275-B, contains the salient characteristics, socket connections, and a special classification index of the complete line of RCA receiving tubes, including the famous Miniature types. Ask your RCA tube dealer or write to the Commercial Engineering Section of the RCA Manufacturing Co., Inc., Harrison, N. J. for your copy.

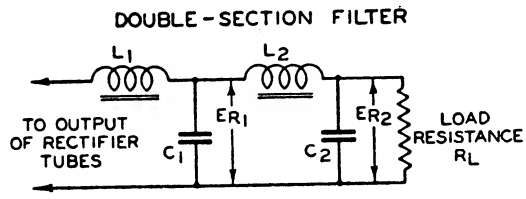
FILTER DESIGN CURVES

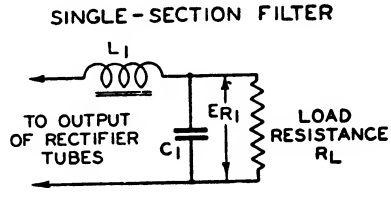
For Full-Wave, Single-Phase Circuits Only—60-Cycle Sine-Wave Supply

(When the supply is a 50-cycle source, multiply the selected values of inductance and capacity by 1.2. When the supply is a 25-cycle source, multiply the filter values by 2.4.)

Fig. 1—Curves for choice of filter values for (1) the first section of a double-section filter, or (2) a single-section filter.
Fig. 2—Curves for choice of filter values for second section of a double-section filter.







E_{RMS}=Maximum volts (RMS) per plate applied to rectifier tube.
R_L=Load Resistance.
E_{R1}=Per cent ripple in D-C output voltage from (1) the first section of a double-section filter, or (2) a single-section filter.
E_{R2}=Per cent ripple in D-C output voltage from second section of a double-section filter.

Simple Curves Make Correct Rectifier Filter Design Easy

(*Continued from page 1, column 4*)

cludes the possibility of encountering serious circuit instability and impairment of filtering caused by 120-cycle resonance.

Choke-Input Filters Desirable

The curves are based on the use of a choke-input filter. This type of filter has many advantages. It provides good voltage regulation, it limits current surges during switching, and also limits the peak plate current during rectifier operation. Its use is preferable from the standpoint of obtaining the maximum continuous d-c output from a rectifier tube under the most favorable conditions. It is especially recommended for use with mercury-vapor rectifier tubes and with high-vacuum rectifier tubes having closely-spaced electrodes. Lastly, the performance of a good choke-input filter can be calculated accurately.

What R_L, E_{r1} and E_{rms} Mean

In Fig. 1, the R_L curves give the minimum inductance and capacitance values that should be used with any specified load resistance. Combinations above R_L may be used with a decrease in output ripple voltage. However, lower than the recommended inductance and capacitance values as indicated by the R_L curve may result in overloading of the rectifier tubes under steady operating conditions as well as in poor regulation. The value of R_L for any specific design is obtained by dividing the required rectifier d-c output voltage by the desired load current (in amperes). The d-c output voltage used for this calculation is taken as 90% of the RMS voltage per rectifier tube plate. It does not take into consideration the regulation of the power transformer, filter choke (s), or rectifier tube (s).

The E_{R1} lines represent the percentage ripple for any single-section filter combination. Always select inductance and capacitance values along the desired E_{R1} line.

The E_{rms} lines show the various combinations of minimum filter inductance and maximum first-section filter capacitance that will limit the surge current to the maximum peak plate current rating of the particular tube it represents, at the maximum peak inverse voltage rating of the tube. An E_{rms} line is given for each rectifier tube type. Always select filter constants along E_{rms} or to the left of E_{rms}.

Lower Voltage, Lower Inductance

When lower than the rated maximum peak inverse voltage is used for a tube type, lower inductance and higher capacitance values may be used without exceeding the peak current rating of the tube. In this case, the filter combination is selected to the left of a new E_{rms} line, the points of which are determined from the equation.

$$L_1 = \left(\frac{E_{RMS}}{I_{MAX.} \times 1110}\right)^2 C_1$$

where

C_1 = First filter condenser capacitance in microfarads
L_1 = First filter choke inductance in henries
$I_{max.}$ = Peak plate current rating of tube in amperes
E_{rms} = RMS transformer voltage per tube

2 Sections Often More Economical

When more filtering is required than can be obtained economically by means of a single filter section, a second filter section may be added to the first. The size of L_2 and C_2 for the second section may be easily determined from Fig. 2. Since E_{R1}, is known for the first section, the values of L_2 and C_2, as a product, may be read from the appropriate E_{R1} curve for any desired value of percentage ripple E_{r2}. Practically any values of L_2 and C_2 forming the product read from the curve can be used for the second section. However, in order to avoid serious circuit instability and impairment of filtering due to 120-cycle resonance, L_2 (in henries) must always be greater than $3 (C_1 + C_2) \div 2C_1C_2$, where C_1 and C_2 are in microfarads.

Simply Follow These Rules

When designing a single-section filter, use Fig. 1 and observe the following rules: *Always select inductance values, (1) above the proper R_L curve. (2) to the left of the proper E_{rms} curve, and (3) along the desired E_{R1} curve. Use the corresponding value of filter capacitance for each selected value of inductance.* When designing the second section of a double-section filter, use Fig. 2 and observe the following rules: *(1) Select desired percentage of output ripple voltage E_{r2} on appropriate curve of E_{R1}. (2) Read corresponding L_2C_2 product. (3) Satisfy this product by choosing convenient values of L_2 and C_2. (4) Check the chosen value of L_2 to insure that it is greater than 3 $(C_1 + C_2) \div 2C_1C_2$.*

Where the load resistance varies over a wide range, good regulation may be obtained by (1) connecting a husky bleeder resistance across the filter output to restrict the range over which the effective load varies, (2) using an input choke with sufficient inductance to meet all values of load resistance up to the highest attained, or (3) using a swinging input choke. The last method is the more economical.

The inductance of a well-designed swinging-choke rises from its normal value at rated load current to a high value at low load current. The required minimum and maximum values of swinging-choke inductance can be determined from Fig. 1 at the intersection of the E_{R1} curve and the desired capacitance value line to the left of the E_{RMS} line. The maximum inductance value then will be found at the intersection of this same capacitance value line and load curve R_L at maximum load. It is generally more economical to select low values of swinging-choke inductance and to depend on additional filter sections to provide the required smoothing.

EXAMPLE No. 1

Problem: Given a d-c output voltage of 3180 volts (corresponds to a peak inverse voltage of 10,000 volts) from a 60-cycle full-wave rectifier employing two 866-A/866's, design a single-section filter of the choke-input type which will limit the ripple voltage to 5% at a load current equal to the combined maximum d-c load-current rating of the tubes (500 ma.), and still prevent the peak plate current of either tube from rising higher than the maximum peak plate-current rating of the 866-A/866.

Procedure: E_{rms} is equal to 3180 x 1.11, or 3535 volts (see January 1941 Ham Tips). R_1 is equal to 3180/0.5 ampere, or 6360 ohms. From Fig. 1, R_1 = 6360 lies below curve E_{rms} = 3535 (as shown for the 866-A/866). Hence, any combination of inductance and capacitance along the curve E_{R1} = 5% and to the left of the curve E_{rms} = 3535 will satisfy the requirements. A suitable combination is a filter section employing a 25-henry choke and a 1-microfarad condenser. Another suitable combination would be a 17-henry choke and a 1.5-microfarad condenser.

EXAMPLE No. 2

Problem: Given a d-c output voltage of 3180 volts (corresponds to a peak inverse voltage of 10,000 volts) from a 60-cycle full-wave rectifier employing two type 866-A/866's, design a double-section filter which will limit the output ripple voltage to 0.5% at a load current equal to the combined maximum d-c load-current rating of the tubes (500 ma.) and still prevent the peak plate current of either tube from rising higher than its maximum peak plate-current rating. The input choke is to be of the swinging type and the voltage regulation is to be good from no-load to full load.

Procedure: E_{rms} is equal to 3180 x 1.11, 3535 volts. At maximum load, R_1 = 3180/0.5 ampere, or 6360 ohms. Therefore, any combination of inductance and capacitance along E_{R1} and to the left of E_{RMS} = 3535 will be suitable. A value of 10% ripple at the output of the first filter section will be assumed to be satisfactory. The minimum value of swinging-choke inductance and corresponding value of capacitance for the first-section filter condenser, therefore, may be selected along curve E_{R1} = 10% and to the left of curve E_{rms} = 3535 volts (for 866-A/866). Suitable values are 13.5 henries and 1 microfarad. The maximum value of swinging-choke inductance to be used with a condenser having a capacity of 1 microfarad should be as high as practical. Assume that this value is 40 henries. Then, with a capacitance value of 1 microfarad the maximum value of R_1 is approximately 44,000 ohms. Therefore, a bleeder resistance of 44,000 ohms is required to keep the d-c output from "soaring" at transmitter no-load conditions. With a load resistance of 44,000 ohms, the bleeder current is 2385/44000 = 0.073 ampere, or 73 milliamperes. The total useful d-c output current is then 500-73, or 427 milliamperes.

Considerations for 2nd Section

The design of the second filter section should now be considered. It must be capable of reducing the ripple voltage from 10% in the first section to 0.5% in its own output. From Fig. 2, the value of the product L_2C_2 is 37 as read on the curve E_{r1} = 10% when E_{R2} = 0.5%. If C_2 is chosen to be 2 microfarads, L_2 = 37/2, or 18.5 henries. This value of L_2 is greater than $3 (C_1 + C_2) \div 2 C_1C_2 = 3 (1 + 2) \div 2 (1 \times 2)$, or 2.25, and therefore is of ample size to avoid resonance effects.

The curves are satisfactory for all ham applications as well as for many commercial filter installations. A little practice working with the curves will be convincing that they are material time savers and simple to use. The performance of a filter chosen from them can be predetermined accurately provided, of course, that the filter equipment employed is of good design and is properly rated.

RCA LOG SHEETS SIMPLIFY "BOOKKEEPING"

The simple, easy way to keep a log is with RCA Log Sheets. Each page is laid out so that the dope pertaining to the communication can be entered from left to right in the same sequence as the procedure of a normal QSO. A highly favored feature of RCA Log Sheets is the right-hand perforations for use in three-ring binders. This places the active sheet to the left and the blank side of the next sheet to the right. Each sheet thus serves a double purpose by acting both as a log and as a handy note page for writing, sketching, and "doodling." RCA Log Sheets come in pads of 25 each. See your transmitting tube distributor for your supply.

New High-Power Triode Has Broad Field of Uses

(*Continued from page 1, column 1*)

of 1240 watts and require only 18 watts of driving power. In class B modulator service, two 8000's will modulate 100% nearly 1½ kilowatts of power.

In self-rectifying oscillator circuits, such as are used in therapeutic applications, two 8000's are capable of delivering a useful power output of 550 watts (85% circuit efficiency). In this application, as well as in general radio transmitter applications, the 8000 may be operated at maximum ratings at frequencies as high as 30 Mc and with reduced plate voltage and input as high as 100 Mc.

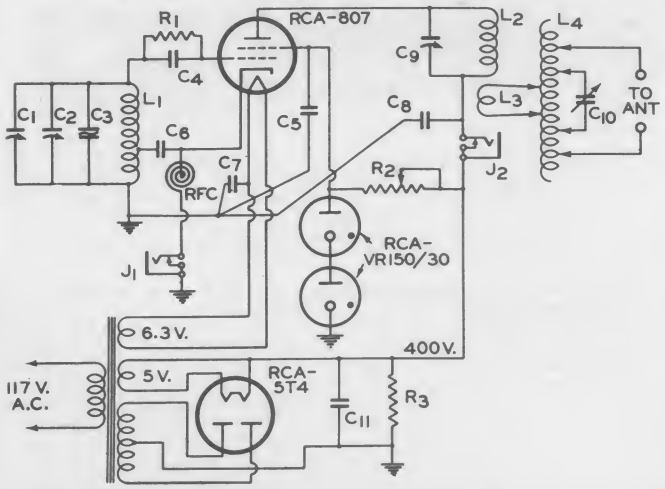
RCA-8000 is designed with a heavy-duty 45-watt filament which is shielded at each end. This feature increases power output by eliminating losses from bulb bombardment and stray electrons. The tube has a large graphite anode, specially processed, to insure high thermal radiation and a minimum of gas. The plate and grid leads are brought out to rugged terminals at the top and side of the bulb respectively. This design provides very low lead inductance and permits compact circuit layout for r-f installations.

A typical single-ended r-f amplifier circuit using the 8000 is shown on p. 1. Keying is shown in the filament-to-ground return lead. If it is desired to key the oscillator for break-in operation, a fixed bias of −90 volts should be used in conjunction with a grid leak (R_1) of about 5000 ohms (10 watts). This amount of fixed bias will protect the 8000 against removal of grid excitation when the key is open. An RCA-809 operated at reduced ratings or an 807 is suitable for the driver stage. For 10-meter operation with an 80-meter crystal, a practical tube line up is an 807 or 6L6 "Tritet" crystal oscillator-quadrupler, an 807 buffer-amplifier and an 809 doubler. The 809 is needed only for 10-meter operation; it may be omitted for the other bands. With a 10-meter crystal and a 6J5-G triode oscillator, an 807 can be used to drive the 807 directly, thereby providing a 3-stage, 10-meter transmitter of respectable power output. This r-f amplifier circuit may also be plate modulated by reducing the d-c plate voltage to 1800 volts and the d-c plate current to 250 ma. These are ICAS values.

With its relatively low plate-voltage requirement for high power output, RCA-8000 is ideal for use in radio transmitter installations as well as being a logical choice in self-rectifying oscillator circuits such as are often used in therapeutic applications. Priced at a net of $13.50 it offers economy not only in initial tube cost but also in cost of the final-stage tank condenser, the high-voltage power supply, and the number of exciter stages required.

For additional technical information on the RCA-8000, write to the Commercial Engineering Section, Harrison, N. J.

W3BKX/3 7-Mc PORTABLE TRANSMITTER

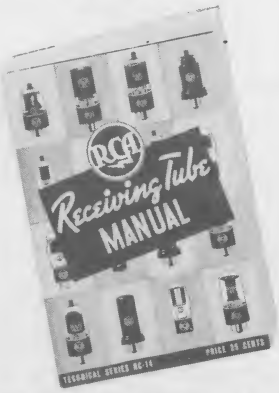


C_1=35 μμf, Max. (Main tuning cond.)
C_2=Air-padder, 235 μμf, Max.
C_3=65 μμf, fixed (Neg. Coeff. Type)
C_4=0.0001 μf, mica
C_5 C_6 C_7 C_8=0.01 μf, mica
C_9=100 μμf, max.
C_{10}=140 μμf, max.
C_{11}=40 μf, electrolytic
R_1=18,000 ohms, 2-watt
R_2=5,000 ohms, 25-watt
R_3=90,000 ohms, 10-watt
L_1=Tuned to 3.5 Mc. 16 Turns No. 16 B. & S. on 1⅜" form winding length, 1⅜". Cathode tapped 4 turns above ground.
L_2=Same as L_1 but without tap.
L_3=3 turns No. 24 enamel wound between lower turns of L_2
L_4=B. & W. type 40-B. 20 turns
J_1=Key jack
J_2=Plate-meter jack
RFC=2.5 mh. choke

RCA-8000 TENTATIVE CHARACTERISTICS and RATINGS

FILAMENT VOLTAGE (A.C. or D.C.)		10	Volts
FILAMENT CURRENT		4.5	Amperes
AMPLIFICATION FACTOR		16.5	
DIRECT INTERELECTRODE CAPACITANCES:			
Grid-Plate		6.4	μμf
Grid-Filament		5.0	μμf
Plate-Filament		3.3	μμf
As R-F Power Amplifier—Class C Telegraphy			
Key-down conditions per tube without modulation			
	CCS	ICAS	
D-C PLATE VOLTAGE	2000 *max.*	2250 *max.*	Volts
D-C GRID VOLTAGE	−500 *max.*	−500 *max.*	Volts
D-C PLATE CURRENT	250 *max.*	275 *max.*	Ma.
D-C GRID CURRENT	40 *max.*	40 *max.*	Ma.
PLATE INPUT	500 *max.*	620 *max.*	Watts
PLATE DISSIPATION	125 *max.*	150 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	2000	2250	Volts
D-C Grid Voltage:			
From a fixed supply of	−195	−210	Volts
From a grid resistor of	8100	8400	Ohms
From a cathode resistor of	710	700	Ohms
Peak R-F Grid Voltage	370	400	Volts
D-C Plate Current	250	275	Ma.
D-C Grid Current (Approx.)	24	25	Ma.
Driving Power (Approx.)	8	9	Watts
Power Output (Approx.)	375	475	Watts

MODERNIZED



21 more pages and 40 new tube type descriptions have just been added to the RC-14. This book is now a virtual encyclopedia of receiving tubes, containing 240 pages covering 283 different receiving tube types. An up-to-date RC-14 may be obtained from your RCA tube dealer, or by sending 25 cents to the Commercial Engineering Section, RCA Manufacturing Company, Inc., Harrison, N. J.

W3BKX/3 Using RCA Tubes Wins Field Day Contest

(*Continued from page 1, column 3*)

small way to the final success of the club. The line-ups are as follows:

Transmitter No. 1—1.8-Mc Phone
RCA-802 electron-coupled oscillator, RCA-807 final amplifier, RCA-56's speech amplifier, RCA-46's class B modulator. RCA-83 and RCA-5Z3 rectifiers. Input to final, 20 watts.

Transmitter No. 2—3.5 to 3.6-Mc CW
RCA-6L6 crystal or electron-coupled oscillator, RCA-807 final amplifier, 2 RCA-VR-150's as ECO voltage regulators, RCA-83 rectifier. Input to final, 30 watts.

Transmitter No. 3—3.6 to 3.9-Mc CW
RCA-6AG7 electron-coupled oscillator, RCA-807 final amplifier, 2 RCA-VR-150's as ECO voltage regulators, 2 RCA-6X5G rectifiers. Input to final, 30 watts.

Transmitter No. 4—7.0 to 7.15-Mc CW
RCA-807 electron-coupled oscillator, 2 RCA-VR-150's as ECO voltage regulators, RCA-5T4 rectifier. Input, 30 watts.

Transmitter No. 5—7.15 to 7.3-Mc CW
RCA-807 electron-coupled oscillator, 2 RCA-VR-150's as ECO voltage regulators, 2 RCA-6X5G rectifiers. Input, 27 watts.

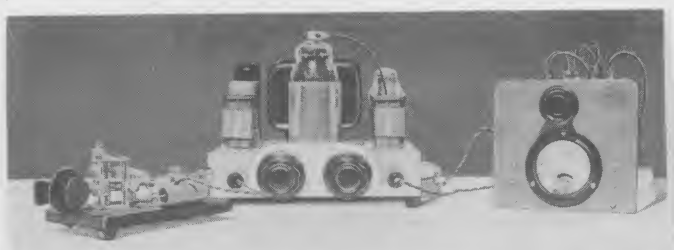
Transmitter No. 6—14-Mc CW
RCA-802 electron-coupled oscillator, RCA-VR-105 and RCA-VR-150 as ECO voltage regulators, 2 RCA-6X5G rectifiers. Input, 27 watts.

Transmitter No. 7—28- and 56-Mc Phone
RCA-6L6 tritet oscillator, RCA-6L6 doubler, RCA-807 final amplifier, 2 RCA-6L6 modulators, and 2 RCA-5Z3 rectifiers. Input, 30 watts.

AR-77 PRICES REVISED

Markedly improved design together with increased manufacturing costs necessitates a slight revision of prices on the new-production AR-77's. Beginning March 1, Amateur Net Prices are: AR-77 only, $162.50; AR-77 with 8" Table. Speaker, $170.50; AR-77 with Extended-Range Speaker Mi-8314-A, $177.50.

PRIZE-WINNING PORTABLE

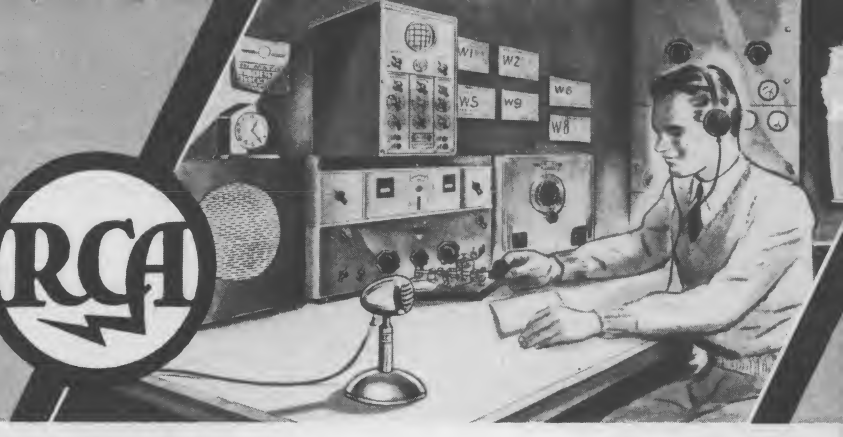


W3BKX/3's transmitter for the 7000-7150 kc. channel consists of an 807 as E.C.O. Self-contained power supply uses a 5T4 rectifier and two VR-150 voltage regulator tubes. Size of the chassis is only 7" x 9" x 2". Antenna coupler is shown to the right of the photograph. Circuit appears above.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation.
Printed in U. S. A.

Form 1G3511

HAM TIPS *from* RCA



Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 4 — No. 3 CAMDEN, N. J. JUNE-JULY, 1941

NEW LOW-COST TUBES FILL VITAL NEEDS IN COMMUNICATION

NEW RCA GUIDE ON XMTG TUBE NATIONALLY ACCLAIMED

72-Page Book Describes 69 Tubes and 5 Transmitters

The finest and most complete engineering and amateur guide on transmitting tubes ever published by RCA is now off the press. It contains comprehensive data on 69 RCA Air-Cooled Transmitting Tubes including the important new types 815, 816, 8000, 8001, 8003, 8005, and the Midget tubes 9001, 9002, and 9003. Complete data supplemented by carefully proven circuits show how RCA Transmitting Tubes may be used to their best advantage. 8½" x 11" in size, the book contains 72 pages and includes more than 150 circuits and illustrations.

Exceptional Rigs Described

Outstanding feature of the new RCA Guide is the transmitters—designed, constructed, and tested specifically for description in this book. Among these transmitters is included complete constructional information on a plate-modulated RCA-815 transmitter operating from 2½ to 20 meters, a high-power, single-control 813 transmitter, an economy transmitter using an 809, and others. All of the equipment described in the book represents a wide range of application and meets modern demands for ready transmitter simplicity coupled with efficiency, economy and flexibility. They are designed to give reliable and outstanding performance.

You can obtain a copy of the RCA Guide from your nearest Transmitting Tube Distributor or by sending 25 cents direct to the Commercial Engineering Section, RCA Manufacturing Company, Harrison, New Jersey.

POWER TUBE BOOK DELUXE

The RCA GUIDE for Transmitting Tubes contains a fabulous treasure of information on radio transmitting tubes and transmitters. It is packed with subjects of high interest to all engaged in the art of radio communication. It is fast reading. The RCA GUIDE is bound in a striking cover and is beautifully illustrated throughout. It is the authority on transmitting tubes you canno afford to be without. Price, 25 cents.

P-P BEAM TUBE, JUNIOR RECTIFIER, UHF MIDGETS, AMONG MANY ANNOUNCED

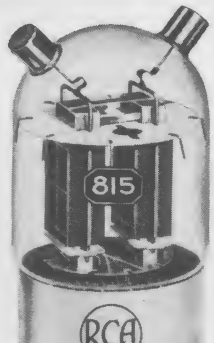
815 Dual Beam Type Takes 75 Watts Input with Only 0.2 Watt Grid Drive Up to 150 Mc

Time is rare in tube history when the announcement of such tremendously important types as the RCA-815, 816, 931, 8001, 8003, 8005, 9001, 9002, 9003 and 12A6 in a single sweep has been paralleled. Each of these new tubes is designed to meet a long standing demand for a low-cost type that will do a real job in the field for which it was intended—the inexpensive 815 for push-pull r-f work down to 2 meters, the one-dollar 816 rectifier to handle the medium-power supply requirements, the 931 multiplier phototube with sensitivity enough to detect the light of stars, the low-cost Midgets that bring uhf experimentation within the reach of all. Little wonder is there then in our belief that this announcement is of import to all those engaged in radio communication.

RCA-815, the new, low-cost, push-pull beam transmitting tube, meets the growing demand by engineers and amateurs for an economical type that will deliver real power on the ultra highs, that requires very little grid drive, that generally needs no neutralization, and gets along on plate voltages of only 400 to 500 volts. The exceptional efficiency of the 815 is made possible by the balanced and compact structure of the beam units, excellent internal shielding, and close electrode spacing. A single 815 operating in push-pull c-w service is capable of handling 75

(*Continued on page 2, column 1*)

P-P BEAM POWER TO 2 METERS



RCA-815 takes 75 watts at the handy plate voltage of 500 volts. It covers the amateur bands from 160 to 2½ meters and requires but one socket, one cathode resistor and one screen resistor.

C_1 C_5 C_6 = 0.001 μf mica.
C_2 C_3 C_4 = 1" x 2" copper plates insulated from chassis by mica sheet 0.015" thick.
L_1 = Two copper pipes 8" long and ⅛" dia., spaced 1⅞", center-to-center.
L_2 = Same as L_1 but 12" long.
L_3 = 8 turns No. 12 wire wound around R_3; diameter of L_3 is twice dia. of R_3.
R_1 = 5000 ohms, 50 watts.
R_2 R_3 = 200 ohms, 2 watts (non-inductive).
S_1, S_2 = Sliding shorting bars.
T_1 = Filament Transformer (7.5 v. 8 a. secondary).

NOTE (1): Connect the two grid terminals and the two plate terminals of each tube in parallel to reduce the respective lead inductances.

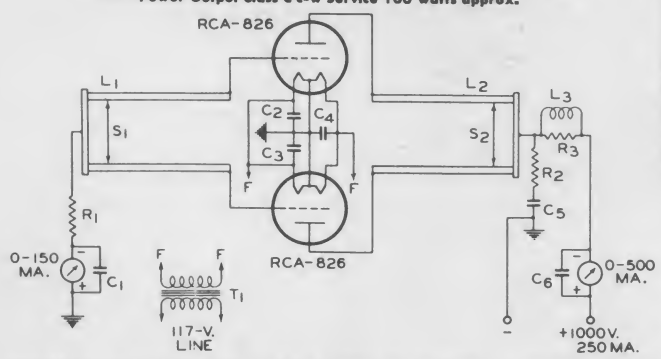
NOTE (2): Metal circuit components carrying u-h-f currents should be silver-plated to obtain maximum efficiency.

JUNIOR OF THE 866-A/866

Two half-wave, mercury-vapor rectifier RCA-816's will deliver 400 watts of d-c power at a total rectifier tube cost of only $2.00.

PUSH-PULL RCA-826 OSCILLATOR, 150-200 Mc

Power Output Class C c-w Service 100 watts approx.



RCA-826 is a ruggedly built triode for use as an oscillator r-f power amplifier and frequency multiplier at the ultra-high frequencies. It has a maximum plate dissipation rating of 60 watts and may be operated with high plate-circuit efficiency at frequencies up to 250 Mc—at reduced ratings up to 300 Mc. The 826 contains a tantalum anode and a double helical thoriated-tungsten filament that is center tapped within the tube to minimize effects of filament inductance.

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New Low-Cost Tubes Fill Vital Needs in Communication

(*Continued from page 1, column 4*)

watts input (ICAS) with less than 0.2 watt of driving power—at frequencies as high as 150 Mc. It may be operated at reduced ratings up to 225 Mc (1¼ meters). The tube is equipped with a big octal-type metal-shell base using low-loss "Micanol" insulation. Its heater may be operated either in parallel from a 6.3-volt supply or in series from a 12.6-volt supply. List price of the 815 is only $4.50.

Jr. Rectifier Has High Ratings

Outstanding among the new tubes is the RCA-816 half-wave, mercury-vapor rectifier—junior of the well-known 866-A/866. The 816 meets the past, present, and future demands for a low-cost rectifier that will handle transmitter requirements too heavy for regular receiving tube rectifiers and yet that are not large enough to require the use of 866-A/866 type. Advantages of the 816 over similar types are (1) its higher peak inverse voltage rating of 5,000 volts made possible by bringing out the plate lead to a separate seal at the top of the bulb, (2) its small receiving tube size, and (3) its long life resulting from use of the famous 866-A/866 type of filament construction. Two 816's operating in a full-wave rectifier circuit are capable of delivering to the input of a choke-input type filter a rectified voltage of 1600 volts at 250 ma., with good regulation, with exceptional life, and at a total rectifier tube cost of only $2.00! List price of the 816 is $1.00.

GAIN—230,000 TIMES

RCA-931 is a 9-stage multiplier phototube of extraordinary sensitivity. It is capable of detecting infinitesimal quantities of light.

HIGH BEAM POWER TO 75 Mc

RCA-8001 takes a maximum plate input of 300 watts as high as 75 Mc with only 1.4 watts of drive—and without need for neutralization.

Phototube Is Supersensitive

RCA-931 is a radically new multiplier phototube of the high-vacuum type having enormous sensitivity, low noise level, low dark current, and freedom from distortion. It can be coupled to any practical load impedance. It is capable of multiplying feeble currents produced by weak illumination as much as 230,000 times! It has practical application in light-operated relays, in sound reproduction from films, in facsimile transmission, and in scientific research involving low light levels. In short, it is one of the most outstanding phototube developments in recent years. The 931 employs an S-4 photosurface which has unusually high sensitivity to blue-rich light such as that produced by mercury-vapor lamps. Sensitivity to incandescent light at a temperature of approximately 2600° K is comparable with that obtained with an S-1 photosurface but it increases rapidly with increasing temperatures. The 931 contains 9 dynodes (secondary emitters). Electrons emitted from the illuminated photo cathode are directed by fixed electrostatic fields along curved paths to the first dynode. The electrons strike the dynode surface and produce many other electrons at the moment of impact. The dislodged electrons are known as secondary electrons. The number of secondary electrons dislodged are dependent on the energy of the impinging electrons. These electrons are then directed to a second dynode and in turn knock out more secondary electrons. This multiplying process is repeated in each successive stage with an ever-increasing stream of electrons, until those emitted from the ninth dynode are collected by the anode and constitute the current utilized in the output circuit. List price of the 931 is $12.00.

Beam Power Plus at 75 Mc

RCA-8001 is a multi-electrode transmitting tube with a maximum plate dissipation rating of 75 watts. The 8001 contains a suppressor and has beam power features. RCA-8001 fills the need by engineers, experimenters, and amateurs for a beam tube that will deliver reasonably high power at the higher radio frequencies. For example, one 8001 will take a maximum plate input of 300 watts at frequencies as high as 75 Mc, with only 1.4 watts of driving power—and without neutralization. The tube is particularly well suited as an r-f amplifier, frequency multiplier, and suppressor-, grid-, or plate-modulated amplifier. It may also be used as a class A a-f power amplifier or modulator and in this service it is capable of delivering approximately 34 watts of audio power with very low distortion. Other features of the 8001 are its dish-type stem which makes possible the use of unusually short internal leads, its hard-glass bulb to withstand extremely high temperatures, its enclosed tantalum anode to insure permanent gas-free operation and to eliminate loss of power from electron bombardment of the bulb, a giant 7-pin base having ceramic insulation and wide pin spacing, and a 37.5-watt thoriated-tungsten filament. List price of the 8001 is $27.50.

DID YOU KNOW THAT - - -

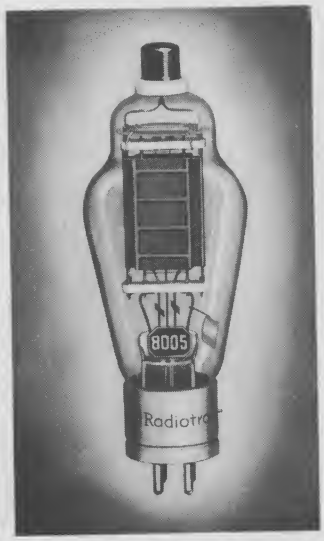
For the third consecutive time, top winners of the ARRL Sweepstakes used RCA Transmitting Tubes! This year, honors go to W3BES, highest national scorer; W9FS, second highest national scorer; and W6ITH, top-flight 'phone contestant. W3BES used two 812's in the final with an 807 driver. W9FS used an 813 final with an 807 driver. W6ITH used a pair of 806's in the final driven by an 814 buffer and an 807 driver.

KING OF THE 100 WATTERS

RCA-8003 delivers 250 watts at the low plate voltage of 1350 volts—up to 30 Mc. It is designed particularly to withstand high peak voltages.

RCA-8003 is a new transmitting triode with a maximum plate-dissipation rating of 100 watts and a low mu of 12. RCA-8003 is suitable for use as an r-f power amplifier, class B modulator, and oscillator. In class C telegraph service, it will deliver a power output of 250 watts. In self-rectifying oscillator circuits such as are used in therapeutic applications, two 8003's are capable of delivering a useful power output of 375 watts when the circuit efficiency is 75%. The tube may be operated at maximum ratings at frequencies as high as 30 Mc—at reduced ratings to 50 Mc. RCA-8003 is designed with the heavy-duty 32.5-watt thoriated-tungsten filament. For a thoroughly dependable triode either in standard transmitter installations or in the special application field, the 8003 is a logical choice. It is as rugged as they come. List price of the 8003 is $12.00.

SUPER TRIODE



RCA-8005 fills the gap between the 812 and 810 types. Only 6 11/16" high and 2 1/16" in diameter, it is capable of handling maximum input of 300 watts (ICAS) up to 60 megacycles!

8005 is Biggest Little Triode

RCA-8005 is the new small-size, high-power transmitting triode de-luxe. It will handle 300 watts input in a tube only 6 11/16" high and 2 1/16" in diameter. It has a maximum plate dissipation of 85 watts and a low mu of 20. The 8005 is designed for use as a radio-frequency amplifier and class B modulator. A single tube in c-w service will handle 300 watts input (ICAS) and deliver about 220 watts of power—with less than 8

(*Continued on page 3, column 1*)

RCA-8005 CHARACTERISTICS and TENTATIVE RATINGS

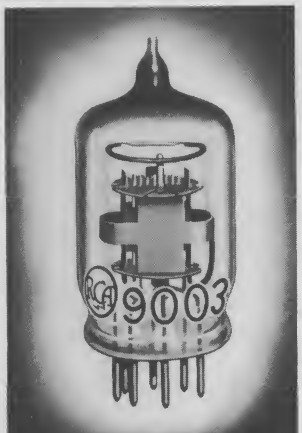
FILAMENT VOLTAGE (A.C. or D.C.)		10.0	Volts
FILAMENT CURRENT		3.25	Amperes
AMPLIFICATION FACTOR		20	
DIRECT INTERELECTRODE CAPACITANCES (Approx.):			
Grid-Plate		5.0	μμf
Grid-Filament		6.4	μμf
Plate-Filament		1.0	μμf
As R-F Power Amplifier and Oscillator—Class C Telegraphy			
	CCS	*ICAS*	
D-C PLATE VOLTAGE	1250 *max.*	1500 *max.*	Volts
D-C GRID VOLTAGE	−200 *max.*	−200 *max.*	Volts
D-C PLATE CURRENT	200 *max.*	200 *max.*	Ma.
D-C GRID CURRENT	45 *max.*	45 *max.*	Ma.
PLATE INPUT	240 *max.*	300 *max.*	Watts
PLATE DISSIPATION	75 *max.*	85 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	1250	1500	Volts
D-C Grid Voltage:			
From a fixed supply of	−115	−130	Volts
From a grid resistor of	3800	4000	Ohms
From a cathode resistor of	520	560	Ohms
Peak R-F Grid Voltage	240	255	Volts
D-C Plate Current	190	200	Ma.
D-C Grid Current (Approx.)	30	32	Ma.
Driving Power (Approx.)	6.5	7.5	Watts
Power Output (Approx.)	170	220	Watts

New Low-Cost Tubes Fill Vital Needs in Communications

(*Continued from page 2, column 4*)

watts of grid drive. In plate-modulated service, it will take 240 watts (ICAS) with only 9 watts of grid drive. In self-rectifying oscillator circuits such as are used in therapeutic applications, two 8005's are capable of delivering an output of 250 watts when the circuit efficiency is 75%. Exceptional among its design features are (1) its hard-glass bulb that is capable of withstanding high temperatures without cracking or collapsing, (2) its Zirconium-coated anode having high heat-dissipating qualities and effective getter action, (3) its ceramic plate cap insulator to minimize corona discharge, (4) a metal shell base with ceramic insulation to withstand high temperatures and provide adequate grid circuit insulation, and (5) its heavy-duty, 32.5-w. thoriated-tungsten filament. It may be operated with maximum ratings at frequencies up to 60 Mc. RCA-8005 is designed and built for RELIABILITY. It will deliver the goods under the most severe conditions of operation—in all classes of service, and it will handle more power than any other tube of its size and class. List price of the 8005 is $7.00.

UHF MIDGET



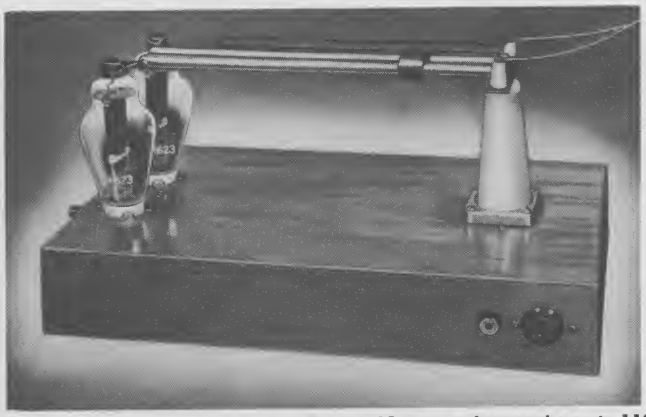
RCA-9001, 9002, and 9003 offer wide possibilities in the economic exploration of the ultra-high-frequencies.

RCA-9001, 9002 and 9003 are the new UHF Midget tubes. They are the answer to the need for low-cost tubes designed particularly for applications requiring high-efficiency, high-gain circuits at unusually high frequencies. For example, the triode 9005 may be used as an oscillator in superheterodyne receivers up to 500 Mc. Electrically, the 9001, 9002 and 9003 correspond to the Acorn types 954, 955 and 956 respectively. Mechanically, the new Midgets utilize the bulb and base structure of the Miniature types. Their convenient button type 7-pin base permits mounting of the tube in a minimum of space. Double cathode leads in each type reduces input loading and provides increased gain. The 9002 has a double plate lead. The new Midget tubes provide the engineer, experimenter and amateur with tubes at reasonable cost that will work well into the ultra-high frequencies. The 9001, 9002 and 9003 list prices are $2.50, $2.00 and $2.50, respectively.

The 12A6 is a beam power amplifier of the metal type with a 12.6-volt, 0.15-ampere heater, well-suited for use in a-c/d-c receivers. With 250 volts on plate and screen, the 12A6 can handle a power output of 2.5 watts with 10% distortion. List price of this tube is $1.50.

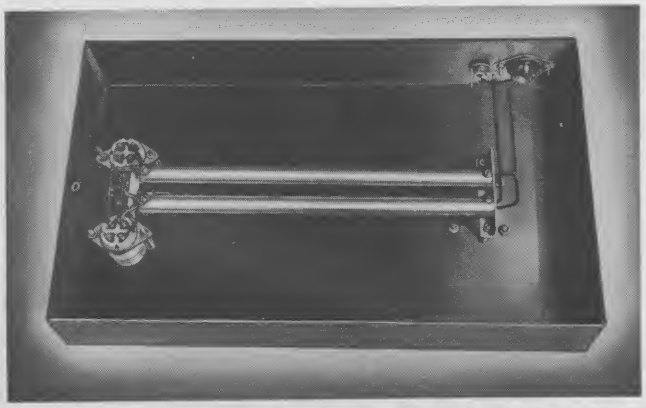
Comprehensive technical information on the foregoing tubes may be obtained by writing direct to the Commercial Engineering Section, RCA Manufacturing Company, Harrison, New Jersey.

PUSH-PULL 1623 OSCILLATOR FOR 2½ METERS



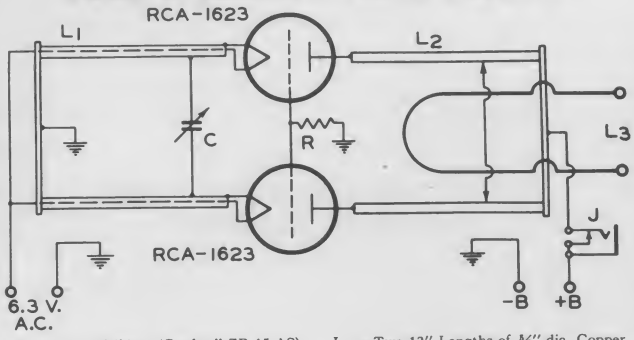
This simple oscillator is capable of delivering 45 watts at frequencies up to 112 megacycles. Features of the unit are its stability of operation and its ease of tuning.

BOTTOM VIEW OF 1623 OSCILLATOR



RCA-1623's were chosen for the job because they are low-mu types and well-suited for oscillator applications. They are unaffected by ordinary plate-load variations and grid-excitation changes.

CIRCUIT OF RCA-1623 2½ METER OSCILLATOR



C = 15 μμf Midget (Cardwell ZR-15-AS).
R = 1000 ohms. 5 watts.
L_1 = Two 12" Lengths of ½" dia. Copper Tubing Spaced 1" Between Centers.
L_2 = Two 12" Lengths of ⅝" dia. Copper Tubing Spaced 1⅛" Between Centers. Shorting Bar 8½" from Plate End.
L_3 = Pick-up Loop, 8" Long.
J = Plate Current Jack.

SIMPLE OSCILLATOR DELIVERS 45 WATTS ON 2½ METERS

P-P 1623's Uses Tuned-Plate Tuned-Filament Circuit

Four feet of copper tubing from the local supply house, a few standoffs and a resistor from the junk box, a pair of economical RCA-1623's, and you're all set to take an active part in the increasing 2½-meter activity.

The simplicity of the circuit of the push-pull 1623 rig can be seen by reference to the circuit shown on this page. A glance at the photographs will demonstrate the straight-forward construction employed. The 1623 is a low-mu version of the RCA-809. It is used in this job because it is less critical to changes in grid-excitation voltage and plate-circuit loading than the 809. The tuned-plate, tuned-filament circuit provides stable u-h-f operation and also permits relatively easy tuning adjustments. The efficient resonant lines take up very little space; each line is only a foot long!

The 1623's should be operated at reduced ratings for 2½ meters. For ICAS telegraph conditions, a measured power output of approximately 45 watts can be obtained with only 200 ma. at 500 volts on the plates. For ICAS phone service, the power output is about 30 watts with 200 ma. at 375 volts. Here's a chance for some of you dyed-in-the-wool low-frequency men to operate in the wide-open spaces on 2½, and enjoy a few pleasant rag-chews—and perhaps even a little skip DX.

Let's go, gang!

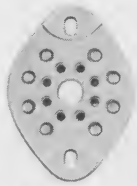
YOUR BOTTLE AT A GLANCE

This 8½" x 11" booklet, known as the TT-100, lists the pertinent data on all RCA Transmitting and Special-Purpose Tubes, including the Acorn types, gas types, voltage regulators, phototubes, cathode-ray tubes, and television tubes. Charts on phototubes and transmitting tubes are provided to facilitate selection of a tube type for a particular service or application. The TT-100 is printed in attractive form and is well illustrated with a multitude of tube photographs. Ask your Transmitting Tube Distributor for your copy, or write direct to the Commercial Engineering Section, RCA Manufacturing Company, Harrison, New Jersey.

LOW-LOSS RCA WAFER AND ACORN SOCKETS NOW AVAILABLE

Designed for Xmtg, Midget, and Acorn Tubes

Introduction of many new high-quality, low-loss sockets for RCA transmitting and receiving tubes, including the Acorn and UHF Midgets, has just been announced by the RCA Parts Section. This new line of rugged, dependable tube mountings consists of six Ceramic Wafer Sockets, a special Midget Wafer Socket, and a special Acorn Socket.



RCA Wafer Socket

The Ceramic Wafers are designed for transmitting, special purpose, and receiving tubes. They have high dielectric properties and low moisture-absorbing characteristics. The top and edge surfaces are glazed and the bottom surface is wax impregnated. Socket contacts are cadmium-plated phosphor bronze having cadmium-plated steel pressure springs. All contacts are recess-mounted to prevent turning. All types other than the octal socket (illustrated) include a circular groove in the top face of the base to facilitate pin location.

The new Midget Wafer Socket, No. 9914, is designed specifically for the new UHF Midget tubes RCA-9001, 9002, and 9003. This socket utilizes a special mica-filled insulation which has low-loss at the ultra-high frequencies. Pin contacts have exceptionally low inter-contact capacity. Net price of this socket is $ .09.

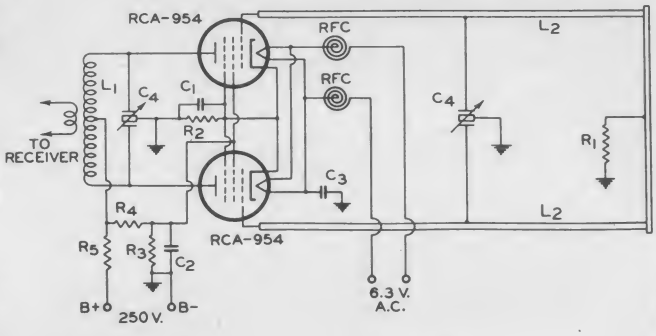
The Acorn socket, Stock No. 9925, is designed specifically for the RCA-954, 955, 956, 957, 958, and 959. This socket utilizes Steatite insulation having extremely low dielectric losses. Top and edges of the socket are glazed to prevent moisture absorption. Grooved silver-plated, beryllium-copper connectors lock the tube in place and provide positive cleaning contacts. A shield plate is included with each socket for use with the pentode type tubes. Amateur net price of this socket is $ .66.

Acorn Socket and Shield

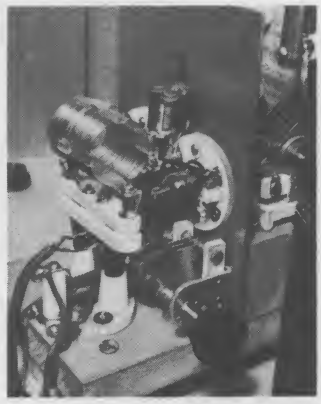
No.	Type	Amateur Net Price
STK-9919	4-contact	$ .36
STK-9920	5-contact	.36
STK-9921	6-contact	.36
STK-9922	7-contact (small pin circle)	.38
STK-9923	7-contact (medium) pin circle)	.38
STK-9924	Octal (Illustrated)	.43

These new units will shortly be available for delivery through your RCA Tube and Equipment Distributor.

W9NNO PRESELECTOR USES 954 TYPE ACORN TUBES IN PUSH-PULL

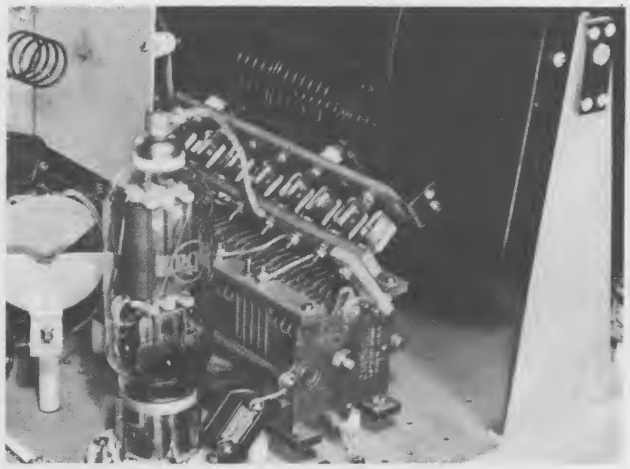


C_1 = .005 μf.
C_2 = .005 μf.
C_3 = .005 μf.
C_4 = See photograph for proportions.
R_1 = 100,000 ohms.
R_2 = 500 ohms.
R_3 = 50,000 ohms.
R_4 = 50,000 ohms.
R_5 = 10,000 ohms.
RFC = 10-meter chokes.
L_1 = Standard low-loss plug-in coil.
L_2 = 15 feet. Tubing spaced 3 inches between centers.



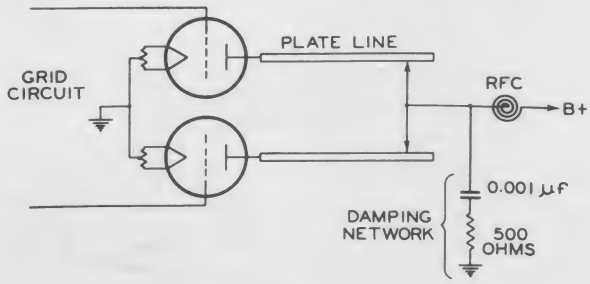
An unusual preselector arrangement has been submitted by Mr. Farrest Nelson, W9NNO, St. Louis Park, Minnesota. The unusual point of interest in the layout is the 954 grid line, which is tuned for 20- and 10-meter operation. This line consists of two 15-foot lengths of ½" diameter copper tubing, spaced appraximately 3" apart. The line is run from the preselector to the ceiling of the shack, then across the ceiling to the opposite wall. To use the same line for 10-meter reception, it is merely necessary to connect a shorting bar across the line at approximately 7½ feet from the amplifier. The grid tuning condenser, C_4, is motor-driven. The motor is controlled at the operating table by a 135-ohm potentiometer connected in a balanced relay bridge circuit.

BAND-SWITCHING 810 FINAL, NE-PLUS



A check for $5.00 is on the way to W6QPD of Glendale, California, for this photo of his business-like 810 final amplifier. The picture shows the coil turret which not only selects the proper inductor for the band in use, but also cuts in the proper tank capacitance. The transmitter is a band-switch affair from stem to stern. Tube complement includes an 807 as crystal or E.C. oscillator, 807 buffer, 810 final, and class B modulator 808's. Every tube in the outfit is RCA. Nice work, W6QPD!

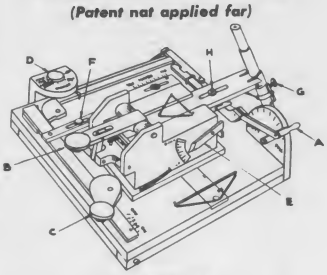
EFFECTIVE NETWORK ELIMINATES PARASITICS IN P-P UHF OSCILLATOR



Very often a troublesome form of parasitic oscillation occurs in push-pull, ultra-high-frequency oscillators or amplifiers. This parasitic is caused by tubes oscillating in parallel at a frequency usually lower than the frequency desired. The oscillation, superimposed upon the normal mode of operation, generally manifests itself by producing instability in the output and by overloading one or the other tubes. A simple and effective method of stabilizing such a circuit is to connect a damping network consisting of a 0.001 μf condenser in series with a 500-ohm, non-inductive resistor from the center-tap of the plate tank (or plate line) to ground. For circuits having inputs up to 150 watts, a 2- or 5-watt carbon resistor should be adequate.

SUPER WATZIT
Automatic Checking Machine Completely Portable, Adjustable, Demountable & Wreckable

(Patent not applied for)



DIRECTIONS

Before operating the checker, see that all gadgets are in normal position—all indicators should be set at 6¾ except levers A, C, D and E which will be at full, on, danger, and up respectively.

To operate—

1. Place Watzit in such a position that the intersection of cross-hairs in sight is superimposed upon one thing or another.

2. Push lever "A" to left until it points to empty.

3. Push down on button "B" until snapping of catch is heard . . .

4. Slide doodad "C" to your left.

5. Pull lever "D" up toward down and Watzit is ready for another operation.

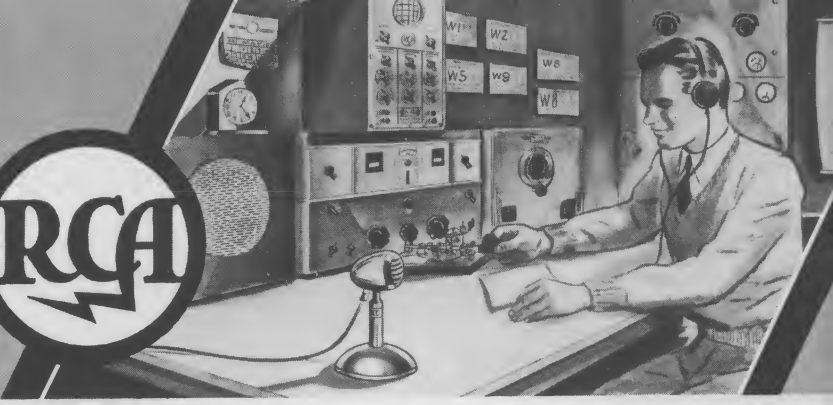
Knob "D" is for operating erasing mechanism. However, since there is no such thing, this knob will be referred to as dummy. To change length of down stroke, move screw "H" in any direction. To change angle of up-stroke, loosen any screw and slide pivot "F" to or fro. If pencil point melts, remove by loosening screw "B" . . . since this is a class 5¼ fit . . . and cockeyed at that.

Important—Never operate button "B" with "A" in "Full" position or Watzit will draw a red line in midair!

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation.

Form 1G3611 Printed in U. S. A.

HAM TIPS from RCA



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VOL. 4 — No. 4 CAMDEN, N. J. NOVEMBER, 1941

MIDGET TUBES ENJOY WIDE APPROVAL BY HAMS AND ENGINEERS

Small, Low-Cost Types Offer Wide Possibilities in UHF Work

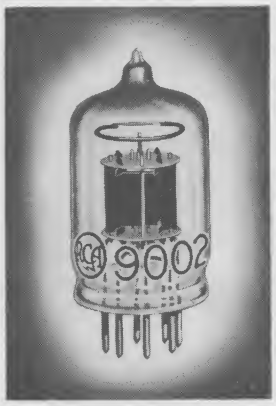
Interest in the RCA-9001, 9002, and 9003 is running high among the uhf gang these days. They are the answer to the need for economical tubes designed particularly for applications requiring high-efficiency, high-gain circuits at unusually high frequencies. Moreover, they have mechanical advantages not to be overlooked since their conventional method of mounting means that they can be inserted and removed from their sockets with ease. And with their maximum height of only $1\frac{13}{16}$" and maximum diameter of only $\frac{3}{4}$" they can be made to fit into just about any space.

The 9001 is the sharp cut-off pentode, the 9002 is a triode, and the 9003 is a remote cut-off pentode. All three tubes are heater-cathode types having 6.3-volt, 150-ma. heaters. Static electrical characteristics are quite similar to the corresponding Acorn types, 954, 955 and 956. Grid-plate capacitance of the pentodes is less than 0.01 $\mu\mu$f, output capacitance less than 3 $\mu\mu$f. Input capacitance for the sharp cut-off pentode is 3.6 $\mu\mu$f; for the remote cut-off pentode, 3.4 $\mu\mu$f.

When tubes are designed for use at the uhf, it is desirable that their interelectrode capacitances be low, that the transit-time loading effect be as small as possible, and that the

(*Continued on page 3, column 4*)

UHF MIDGET



RCA-9001, 9002, and 9003 are the new special Midget tubes for use by engineers, experimenters, and amateurs working in the uhf. They are particularly well suited for FM, Television, and other applications requiring high-efficiency, high-gain circuits at high frequencies.

LOW-COST P-P BEAM TUBE FINDS MULTITUDE OF HAM XMTR USES

RCA-815 Delivers 25 to 35 Watts at 112 Mc in Novel Resonant-Line Oscillator

More stations are cropping up on the ultra highs every day. This area of the radio spectrum is attractive. It offers much to the amateur who likes to tinker with new modes of transmission and new types of directive antenna arrays; it provides QRM-free channels for the dyed-in-the-wool rag chewer who enjoys chatting with the local boys across town. It's a place for new adventure. It is with these thoughts in mind that we offer an unusual $2\frac{1}{2}$-meter application of the RCA-815 twin beam transmitting tube. This inexpensive little bottle really fills a large gap in the uhf tube line from which the amateur must choose in designing his "ultra-high" gear. Although the 815 really shines as an r-f power amplifier at frequencies up to 225 Mc, we thought a bit of data on its use in a simple, resonant-line oscillator might have interest. Hence, such a gadget was constructed in our Transmitting Tube Laboratories and the complete story follows.

Grid Circuit is Tuned

The circuit of the $2\frac{1}{2}$-meter oscillator is shown on this page. Basically, it is of the conventional tuned-plate, tuned-grid type employing "quarter wave" resonant lines in both the grid and the plate circuits. The oscillator is tuned over the 112-116 Mc amateur band by

(*Continued on page 2, column 1*)

WIN $5.00!

Checks to the winners of suggestions and station photographs in this issue are on their way to W3EYM, K7FST, and W3NT. Good kinks and good pictures pay off. Send us those little pet ideas and let's see your station photo. Those published win $5.00 cash.

(This offer is good in Western Hemisphere, Hawaii, and the Philippine Islands.)

RCA GUIDE HITS NEW HIGHS AMONG POWER TUBE USERS

Amateurs, Engineers find Xmtg Tube Book Invaluable

The RCA Guide for Transmitting Tubes is setting unprecedented records for demand by Hams and Engineers. Its 72 pages are packed with subjects of high interest to all engaged in the art of radio communication. It contains comprehensive data on 69 RCA Air-Cooled Transmitting Tubes. This data is supplemented by carefully proven circuits that show how RCA transmitting tubes may be used to their best advantage.

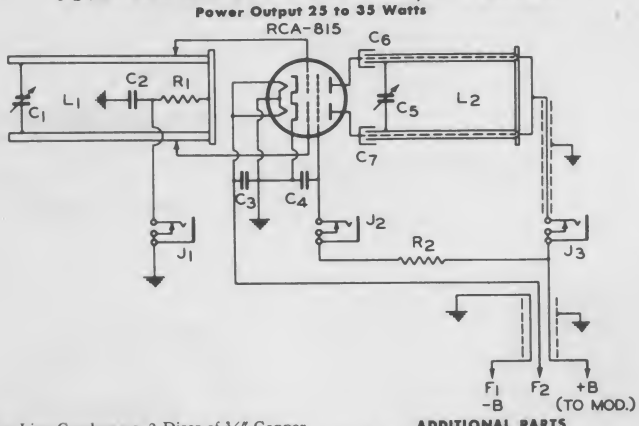
The RCA GUIDE is bound in a striking red cover and contains more than 150 circuits and illustrations. Get your copy from your RCA Tube and Equipment Distributor or send 25 cents direct to the Commercial Engineering Section, RCA Manufacturing Company, Harrison, N. J.

330 WATTS INPUT

RCA-8003 is "big-time" among the 100-watters. It will deliver up to one-quarter kw output with the relatively low plate voltage of 1350 volts, it will take maximum ratings up to 50 Mc, it is built particularly to withstand high peak voltages. The 8003 is a thoroughly dependable triode for transmitters or for special applications. It's as rugged as they come.

PUSH-PULL RCA-815 OSCILLATOR, $2\frac{1}{2}$ METERS

Power Output 25 to 35 Watts



C_1 C_5=Line Condensers. 2 Discs of $\frac{1}{4}$" Copper 2" Diameter mounted on 10-32 Brass Screws.
C_2 C_3 C_4=0.001 μf mica, 600 v. (Aerovox #1467)
C_6 C_7=Plate line d-c isolation condensers 0.010" copper sheet 1" long wrapped around outside of $\frac{1}{2}$" tubing. 0.002" mica insulation.
L_1=Grid Line. 1" O.D. Copper Tubing 21" long, spaced $1\frac{7}{8}$" between centers.
L_2=Plate Line. $\frac{1}{2}$" O.D. Copper Tubing 13" long, spaced $\frac{7}{8}$" between centers.
R_1=10000 ohm, 1 watt (IRC #BT-1).
R_2=15000 ohm, 25 watt (IRC #DHA) (Adjust to 14000 ohms).
J_1 J_2 J_3=Meter jacks (Mallory "Midget" #A-2).

ADDITIONAL PARTS

1 RCA-815.
1 Chassis $\frac{1}{8}$" aluminum or 16-gauge sheet iron. 4" x $4\frac{1}{4}$" x $17\frac{1}{2}$".
1 Ceramic socket (National #XC-8).
1 Shielded microphone plug (Amphenol #MCIF and standard microphone plug attachment)
1 Rubber insulating "Boot" (Mueller #29).
NOTE: The various components which have been mentioned by manufacturers' trade names in this unit are the parts that were actually used. Other parts may be substituted with equally good results, provided they have similar characteristics.

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Low-Cost P-P Beam Tube Finds Multitude of Ham XMTR Uses

(*Continued from page 1, column 4*)

means of disc-type condensers (C_1 and C_5) mounted near the open end of each resonant line. D-c grid bias for the 815 is provided by the 10,000-ohm grid leak, R_1. The d-c screen voltage is obtained from the *modulated* plate supply through dropping resistor R_1.

In order to remove the d-c plate voltage from the plate lines, the plates of the oscillator are capacitance-coupled to the plate line by means of condensers C_6 and C_7. The d-c plate voltage is fed to the plate side of these condensers by means of insulated wires (shown in dotted lines) running through the center of each plate rod. The constructional details of condensers C_6 and C_7 are given under CONSTRUCTION. Three meter jacks provide for the measurement of the d-c grid, screen and plate currents. A 0 to 25-ma. and a 0 to 300-ma. meter are suitable for these current measurements.

Circuit is Novel, Clean-Cut

The circuit arrangement, in conjunction with the RCA-815, has a number of worthwhile advantages for uhf operation. These may be summarized as follows:

(1) Push-pull operation with almost perfect circuit symmetry.

(2) Minimization of degenerative effects due to low cathode- and screen-lead inductance. The cathodes and screens of the two beam power units are tied together *within the tube* to provide short leads.

(3) Good frequency stability due to the use of a high-Q grid line.

(4) Ease of frequency adjustments because both plate and grid lines are tuned with condensers. This arrangement eliminates the use of sliding shorting bars with their usual contact losses and variations in grid drive and plate coupling as the slider is moved.

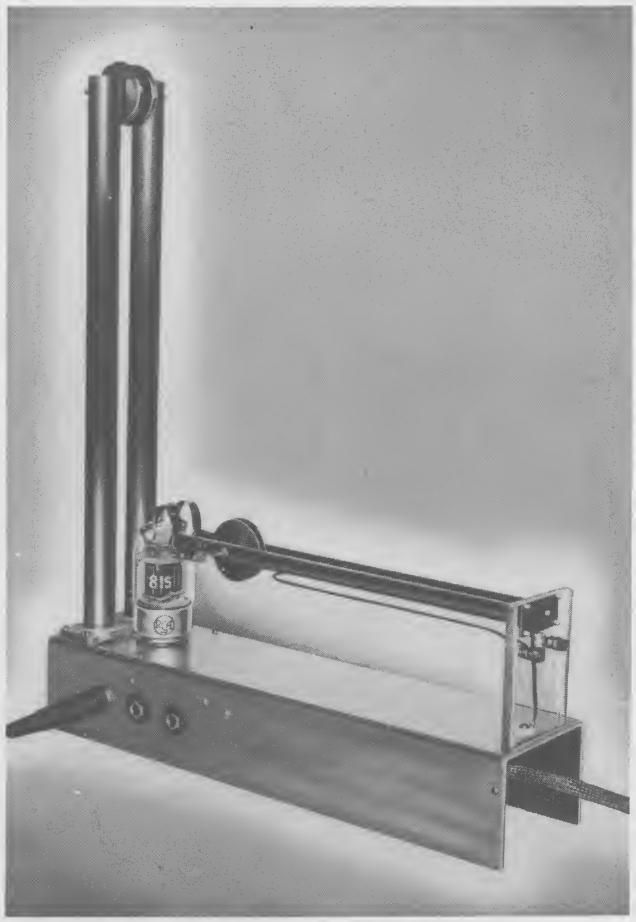
The Layout is Effective

Before the actual construction of the oscillator is taken up, it may be helpful to explain the reasons for the particular mechanical layout employed. In order to obtain good frequency stability, a high-Q grid line is used, with the grids tapped near the shorted end (current maximum) of the line. It is possible to obtain higher output with the grids connected across the open end of the grid line, because of the greater driving voltage available. However, this connection impairs the frequency stability of the oscillator because it necessitates a physical shortening of the high-Q section of the grid line. One-inch copper tubing was chosen for the grid line because its rigidity eliminates the need for spacing insulators near the voltage end of the line and because it provides the desired high-Q circuit. The 815 has such excellent grid-plate shielding that it will not oscillate when the grid and plate circuits are isolated from each other. Therefore, sufficient external feedback must be provided to permit oscillation. The necessary coupling is provided by locating a portion of the grid line near the plate circuit. Since the layout and circuit arrangement have been chosen to minimize parasitic problems and bugs, it is suggested that the layout be carefully followed.

The construction of this oscillator is relatively simple, the type of construction and the general layout used is illustrated on pages 2 and 3. Short leads and adequate grid-plate coupling are obtained by mounting the grid line vertically at one end of the chassis, close to the 815, and by mounting the plate line horizontally above the chassis at a level with the plate terminals. Efficient operation is obtained by supporting each line at points of low r-f potential, and by keeping all insulating materials away from points of high r-f potential. Freedom from frequency wobble is obtained by making use of large copper tubing for the grid and plate lines. These lines are adequately supported on a heavy chassis.

The chassis is made of ⅛" sheet aluminum, bent into a "U" shape 4¼ x 4 x 17½ inches. Sheet aluminum was used at the time the model was built but sheet iron may be used with almost equally good results. The 815 grid leads are tapped about 2½ inches from the shorted end of the grid line to minimize the effect of grid-circuit variations on operating frequency. Solid support of the grid line with a minimum of insulating material at points of high r-f potential is provided by two Polystyrene blocks, spaced about 4½ inches at the shorted end of the line.

PUSH-PULL 815 OSCILLATOR AT 2½ METERS



This novel single-tube oscillator delivers 25 to 35 watts on 2½ meters. High-Q lines are used for maximum frequency stability. The oscillator is tuned by capacitative means. This eliminates need for sliding shorting bars and the possibilities of contact losses and grid drive variations.

Constructing the Grid Lines

Grid-line condenser, C_1, is made of two copper discs 2 inches diameter, mounted on brass screws as noted in the circuit legend. The upper Polystyrene support for the grid line (fastened to the top of the chassis) is drilled with two 1-inch holes, 1⅞ inches between centers, so that it can be slipped over the end of the line. The lower support (located at the bottom of the chassis) is bolted to the copper shorting plate which in turn is soldered to the lower end of the line. A piece of Bakelite, or similar insulating material, can be substituted for the lower piece of Polystyrene, because this section of the line is very close to ground potential for radio-frequency.

When assembling the grid-line structure, it is important to mount the tuning-condenser plates first, and then to slip the drilled Polystyrene strip into place before the copper shorting plate is soldered to the lower end of the line. If the assembly is not carried out in this order, it will be impossible to mount the condenser plates. For the soldering operation, the drilled piece of Polystyrene should be slipped to the far end of the line. Polystyrene melts easily. As the soldering iron of the average ham is too small for such large tubing, a blow torch of some kind will usually be necessary.

After the shorting plate has been soldered to the line and allowed to cool, it should be bolted to the lower piece of Polystyrene (or Bakelite, as the case may be). This insulator is then bolted to the bottom edges of the chassis. As can be seen by reference to the top view of the chassis, the grid leads are made of thin copper strips, wrapped and bolted around each grid rod about 2½ inches from the shorted end. A thin copper plate is bolted between the 815 socket and the chassis to provide a common ground for all r-f circuits. Both cathode terminals (pins No. 3 and No. 6), as well as the ground side of all bypass condensers, should be connected directly to this common ground.

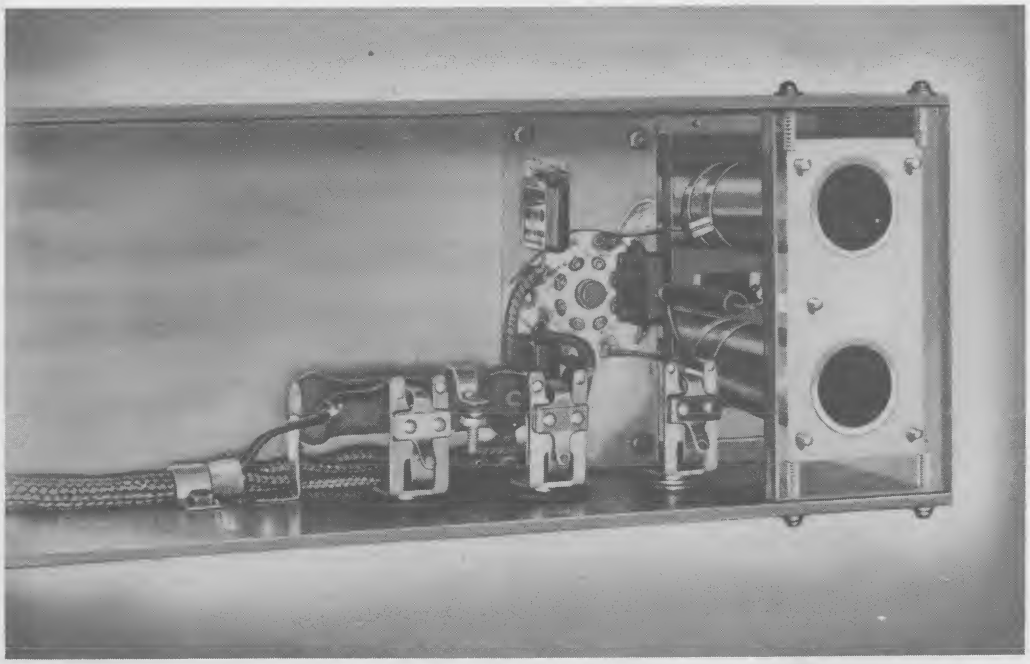
The plate line is made of two pieces of ½-inch copper tubing. Both the plate line and the antenna coupling loop are mounted on a Polystyrene block bolted to the end of the chassis. It is possible to use a metal plate to support the plate line, because the shorted end of the line is at approximately ground potential for r-f, and because the whole line is insulated from the d-c plate voltage. If the metal plate is used, feed-through insulators can be used to support the coupling loop.

Safety Measure Real Feature

Insulation of the plate line from the d-c plate voltage will help to prevent many a nasty shock when the transmitter is adjusted and tuned. This feature can easily be arranged by feeding the plate voltage to the plates of the 815 by means of the insulated wires passed through the center of the copper tubing. R-f coupling between the 815 plates and the plate line is improved by installing condensers C_6 and C_7. These condensers are made by wrapping and bolting a piece of one-inch copper strip around each plate rod at

(*Continued on page 3, column 1*)

BOTTOM VIEW OF 815 OSCILLATOR/XMTR



Simplicity and solid construction are the keynote of this equipment. The oscillator may be modulated up to 80 per cent with good linearity. It requires 16 to 19 watts of a-f power to do the job. A pair of 6L6's in p-p class AB_1 will deliver this power.

Low-Cost P-P Beam Tube Finds Multitude of Ham XMTR Uses

(Continued from page 2, column 4)

the plate end. Mica, 0.002 inch thick, is used to insulate the copper strip from the rod.

Before the 815 oscillator is actually tested, it is important that the meter leads be adequately shielded. About 4 feet of rubber-covered, shielded microphone cable, with a shielded microphone plug such as the Amphenol #MCIF, can be used for this purpose. In addition to this shielding, a 0.005 μf mica condenser should be connected directly across the meter terminals. A rubber boot should be used to protect misguided fingers from the exposed metal of the jack, since both the plate and screen jacks are "hot."

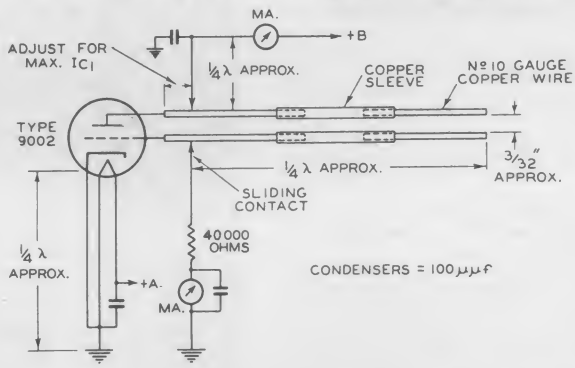
Ready to Tune and Adjust

When the 815 oscillator unit is ready to be tested, it is advisable to use a 2000-ohm, 50-watt protective resistor in the –B lead until the proper circuit adjustments have been made. In adjusting the grid circuit, it will be found that the grid line will tune to 112 Mc when the spacing of C_1 is about ⅜ inch for the dimensions given. With a 0-25 ma. meter plugged into the grid jack, the plate condenser, C_5, should be tuned until about 3 to 5 ma. of grid current flows. This condition indicates oscillation. The protective resistor can now be removed and the antenna feeders connected to the coupling loop. C_5 should be tuned slightly on the inductive (low capacitance) side of minimum plate current in order to insure sufficient grid current.

The loading can be increased by gradually bending the coupling loop closer to the plate line, until a plate current of 150 ma. flows, with C_5 tuned to resonance. The screen current should be about 15 ma., and the grid current about 3 ma. With these adjustments, the power delivered into the antenna feeders is about 27 watts for CCS conditions, and 34 watts for ICAS conditions—class C telegraphy.

For class C telephony service, it is possible to modulate the 815 oscillator 80% with good linearity. Beyond this, the negative peaks are cut off, due to the tube dropping out of oscillation. About 16 watts of modulating power is required for the CCS conditions, and 19 watts for the ICAS conditions. This amount of power can readily be supplied by two 6L6's operated in push-pull class AB_1.

600-Mc OSCILLATOR USING MIDGET TRIODE 9002



Midget Tubes Enjoy Wide Approval by Hams and Engineers

(Continued from page 1, column 2)

lead inductance be low. In the Midget tubes, as in the Acorn tubes, the transit time is decreased by bringing the cathode, grids and plate close together. The interelectrode capacitances are decreased by using small cathodes, grids and plates. Short, internal leads and low lead inductance are insured through the use of the glass-button stem structure and the single-ended design. Each tube has two cathode leads. These leads may be used in parallel, or as separate returns for input and output circuits, in order to reduce the commond feedback inductance. The triode 9002 also is designed with two plate leads.

In application, the Midget tubes may be used in uhf equipment the same way that ordinary tubes are used in standard broadcast receiver application. For example, a typical short-wave receiver might employ 9001's or 9003's in the r-f system as r-f amplifier and mixer. The 9002 could be used as the oscillator. The choice of the sharp or the remote cut-off pentode as r-f amplifier or mixer will depend on the range of signal strengths which it is desired to handle. In the i-f stages, 9001's or 9003's could be used when the i-f frequency is above 100 Mc. The Midgets may also be used in other applications, such as resistance-coupled audio amplifiers and biased detectors, particularly when there are limits on space and weight. The circuit on this page shows the 9002 employed as an oscillator. Under the conditions given, the oscillator will perform smoothly at frequencies as high as 600 Mc with a plate input of 1.6 watts! It is designed for use with tuned grid and plate lines ¼-wave long. Complete technical information on the 9001, 9002 and 9003 may be obtained by writing to the Commercial Engineering Section, RCA Manufacturing Company, Harrison, N. J.

SHIP-SHAPE GEAR FROM STEM TO STERN

W3NT of Norfolk, Virginia, wins the five-spot for one of the neatest layouts we have seen in a long time. The business end of the station consists of two separate exciters. The final uses a pair of RCA-860 screen-grid types. Each exciter may also be used separately as a portable rig. Total tubes in transmitter amount to nearly thirty . . . and they are all RCA!

HAM TIPS from RCA

100% RCA WITH 808's IN FINAL

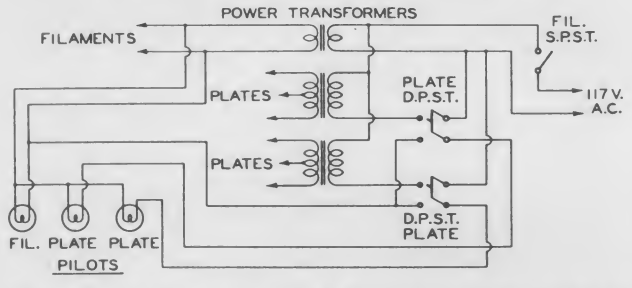
K7FST hits the jack pot with this prize-winning station. Tube line-up in the r-f section is 6L6 oscillator, 802 doubler, 807 buffer, and 2-808's final. Audio section ends up with a pair of 838's. Says K7FST, "I have always been a 100% RCA Tube user. They give you the biggest value ever." Thanks, Om.

STATIC

I married an OW, a widow with a grown daughter. My OM fell in love with my step-daughter and married her. Thus he became my son-in-law. My step-daughter become my maw because she was my father's YF. Then my OW gave birth to a young squirt who become my OM's brother-in-law and my uncle for he was the brother of my step-mother. My OM's YF gave birth to a son. This young squirt become my brother and also my grandchild for he was the son of my daughter.

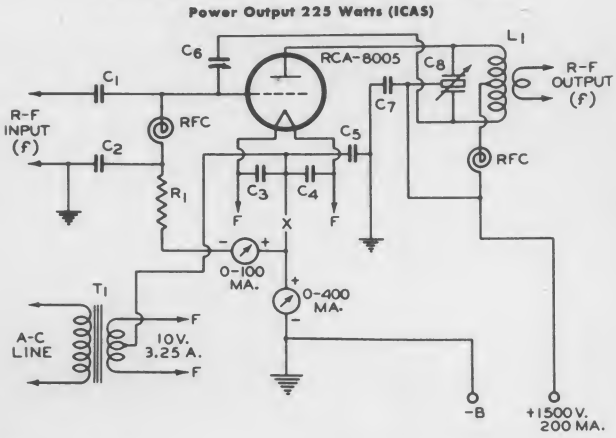
Accordingly my YF is my grandmaw because she is my maw's maw. At the same time, I am my YF's husband and grandchild. And since a husband of one's grandmaw is his grandpaw, I am my own grandpaw.

W3EYM SUGGESTS NOVEL PILOT LAMP SYSTEM



To connect 6.3-volt pilot lamps across a filament transformer winding is no trick. But to connect 6.3-volt pilot lamps in such a way as to indicate plate voltage too, is a trick. W3EYM ingeniously solved the problem by using D.P.S.T. switches in the primary of each plate-supply transformer. Actually the plate-voltage indicator pilots are connected across the filament transformer. One pole of the D.P.S.T. switch makes and breaks this circuit simultaneously with the other pole which makes and breaks the primary circuit of the transformer primary. It's a good wrinkle that nets W3EYM five smackers through the compliments of HAM TIPS.

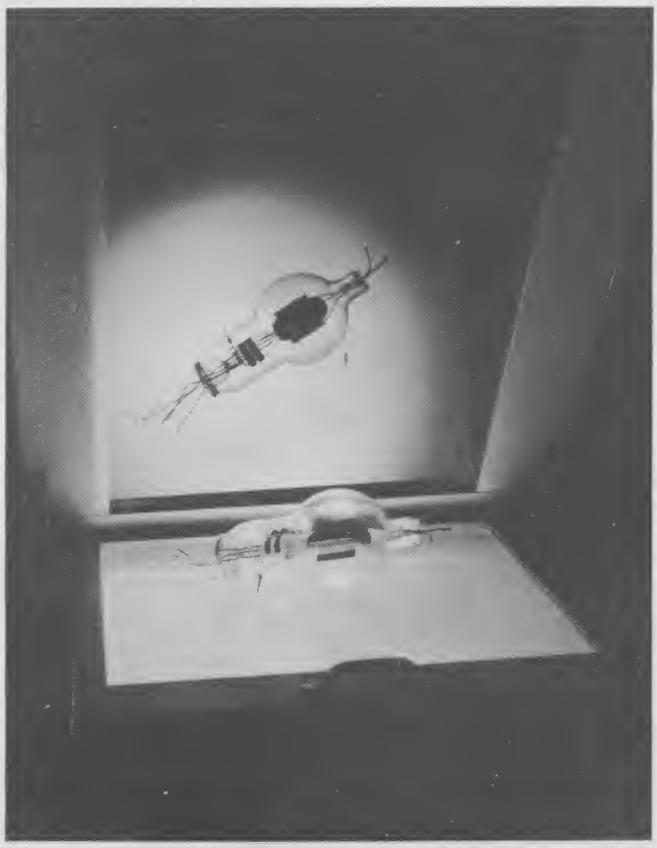
R-F POWER AMPLIFIER USING RCA-8005



C_1=0.0005 μf mica, 1000 v.
C_2 C_3 C_4=0.005 μf, mica.
C_5 C_7=0.002 μf, mica, 2500 v.
C_6=5 μμf (approx.) 6000 v.
C_8=0.85 μμf/meter/section, 2000 v.
R_1=4000 ohms, 10 watts.
RFC=R-F choke.
X=Keying relay.
T_1=Filament transformer.
L_1=Tune to frequency "f".
f=Operating frequency.
NOTE: Rotor shaft of C_8 is at the high d-c plate potential. An insulated coupling shaft must be inserted between the rotor shaft of C_8 and its control dial.

RCA-8005 is the most powerful of the small triodes. It handles 300 watts input in a tube only 6 11/16" high and 2 7/16" in diameter. It has a maximum plate dissipation of 85 watts (ICAS) and may be operated with high plate-circuit efficiency at frequencies up to 60 Mc—at reduced ratings up to 100 Mc. Outstanding features of the tube are its Zirconium-coated plate, hard glass bulb, ceramic plate-cap insulator, metal shell base with ceramic insulation, and an extra-duty, 32.5-watt thoriated-tungsten filament.

POLARISCOPE



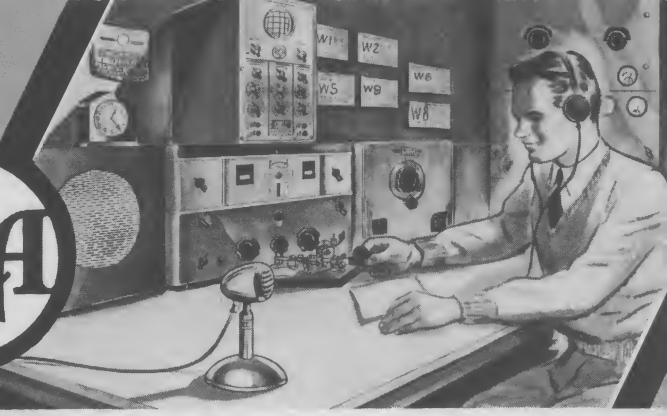
The tube structure has passed all exacting RCA tests, but what of its glass envelope? This polariscope tells the story. The slightest stress or strain in the glass becomes evident in the path of polarized light. By inspecting in this manner, the danger of leakage or breakage is eliminated—and engineering corrections can be made. As always, the aim is to supply you with tubes of unquestioned dependability in every physical and electrical characteristic.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation.

Form 1G4797

Printed in U. S. A.

HAM TIPS *from* RCA



Published by RCA Manufacturing Company, Inc., Camden, N. J., U. S. A.

VOL. 5 — No. 1 CAMDEN, N. J. JANUARY, 1942

VFO GIVES 10 TO 25 WATTS OUTPUT FROM 10 TO 160 METERS:

EXCITER DRIFTS LESS THAN 20 CYCLES PER HOUR AFTER 40-MINUTE WARM-UP PERIOD

802 ECO/807 Amplifier Unit Works Break-In With Clean-Cut Keying on All Bands

*By R. B. Lincoln**

DID YOU KNOW THAT . . .

The largest tube sold by RCA stands over five feet high and is capable of delivering 100,000 watts output . . . and that the smallest tube sold by RCA is only the size of an acorn and can handle an input of ¼ to 1½ watts.

Variable frequency oscillators and ECO's, signal spotters and QRM dodgers, up the band and down—comes a new signal and the channel goes jitterbug. Confusion? Most certainly not. It's the new technique of ham communication—shifting frequencies to increase the percentage of QSO's, saving time on calling and message handling, minimizing QRM.

Most simple way of obtaining instant frequency change in any given band is by means of a variable frequency oscillator, usually operated in conjunction with buffer/doubler stages to provide the desired output at the desired frequency. No subject in recent years has become more popular than that of the amateur VFO. A thousand and one articles have been written on a thousand and one versions of it. Most of the discussions are good, some are outstanding. As usual, none of the devices seemed to have *all* the features that seem important. Thus we set out to design and build an experimental VFO that had them—and we think we accomplished our aims.

Built for Maximum Stability

The variable frequency oscillator described in this article was built with a view to obtaining (1) maximum frequency stability, (2) break-in operation, (3) chirpless keying, (4) five-band operation, (5) high power output with a minimum of tubes, (6) wide bandspread on all bands, (7) high reset accuracy, and (8) a self-contained power supply. Since it was found that with reasonable care it was possible to reset this VFO within

(Continued on page 2, column 1)

* Formerly of the Research and Engineering Dept., RCA Mfg. Co., Inc., Harrison, N. J.

DELUXE 5-BAND VFO WITH HIGH-POWER OUTPUT

This thoroughly engineered VFO meets modern requirements for a master-control oscillator having exceptional frequency stability, break-in operation, chirpless keying, 5-band operation, high-power output, a minimum of tubes, wide bandspread on all bands, high dial-reset accuracy, and a self-contained power supply.

ENGINEERING HANDBOOKS

These loose-leaf volumes are the engineering authority on RCA tubes. They contain complete data and curves on all transmitting, receiving, cathode-ray, television, and special-purpose types. They are a real engineering guide and an essential reference for circuit designers.

RCA TUBE HANDBOOKS INDISPENSABLE TO RADIO ENGINEERS

Contain Complete Technical Data And Curves for Designers

Little heard of in radio amateur circles but vastly important throughout the field of radio engineering are the RCA Tube All-Types HB-3 Handbooks. These loose-leaf volumes, bound in flexible fabricord binders, contain the most complete assembly of data and engineering curves on tubes of all types ever compiled. They cover transmitting tubes, cathode-ray tubes for television and oscillograph use, receiving tubes, phototubes, and special-purpose tubes such as the UHF Acorns and Midgets, Low-

(Continued on page 3, column 4)

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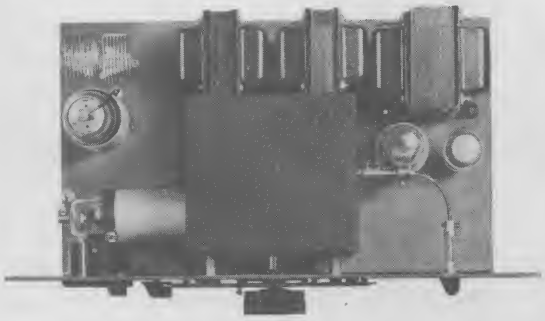
TOP VIEW OF DELUXE 5-BAND VFO



Simplicity and solid construction are key-notes of this instrument. The vital 802 control-grid circuit is enclosed in the central shield box. Note the dial-mounting arrangement and the extension of the 802 horizontally away from the box. The 807 buffer/doubler stage is rear left on the chassis, the power supply rear right.

VFO Gives 10 to 25 Watts Output

(*Continued from page 1, column 4*)

a few hundred cycles (3.5-Mc band) of a marked point on the large band-spread dial—and do it consistently, no provision was made for the inclusion of crystals for spot-frequency operation.

Uses 802 ECO at Reduced Ratings

A great many VFO's do their best work on but one or two bands. If small tubes are used, or if the fundamental frequency band (the band to which the frequency-controlling grid circuit is tuned) is relatively low, a string of doublers is required to reach the higher frequency bands. Moreover, the multiple doubling system provides very poor bandspread at the higher frequencies. On the other hand, if a higher fundamental grid-circuit frequency is used to obtain higher output and to improve the bandspread characteristic, then it often becomes necessary to forfeit operation on one or more of the low-frequency bands. Consequently, in this VFO it was decided to use the well-screened 802 as the electron-coupled oscillator and to operate it at greatly reduced ratings. Operation of the tube at reduced ratings minimizes frequency drift caused by slightly changing interelectrode capacitances while the tube heats up. Unquestionably, a receiving tube may also be operated as an oscillator to provide equally stable frequency characteristics. But by the time the input of the tube has been reduced sufficiently to obtain the desired stability, its useful output will have dropped nearly to the vanishing point. Then, an extra amplifier or so is required to make up the loss of power. The 802 in this VFO operates at a plate voltage of approximately 470 volts, at a screen voltage of 105 volts (regulated by a VR-75-30), and at a plate current of only 8 to 10 ma.! Yet even at these low ratings the tube furnishes enough power to drive an 807 operating as a buffer, doubler, or quadrupler to a fairly respectable output. And needless to say, the 802 runs very cool under these conditions. Frequency drift during warm-up periods is very small—about 400 cycles at 3.5 Mc.

807 Used as Buffer/Doubler

The 807 used in this VFO operates either as a buffer amplifier, doubler, and quadrupler depending on the frequency to which the ECO is tuned. The 807 operates at a d-c plate voltage of approximately 470 volts and a d-c plate current of 100 ma. at full load. D-c screen voltage is approximately 150 volts. Under these conditions, the 807 stage is capable of delivering to a lamp load a power output of approximately 5 watts at 10 meters to 25 watts at 160 meters—enough output to drive a pair of 812's to full output all the way down to 20 meters, and at reduced output to 10 meters. In fact, during these power output measurements it was found that with very careful adjustment it was possible to drive a second 807 on 5 meters!

Grid Circuit Considerations

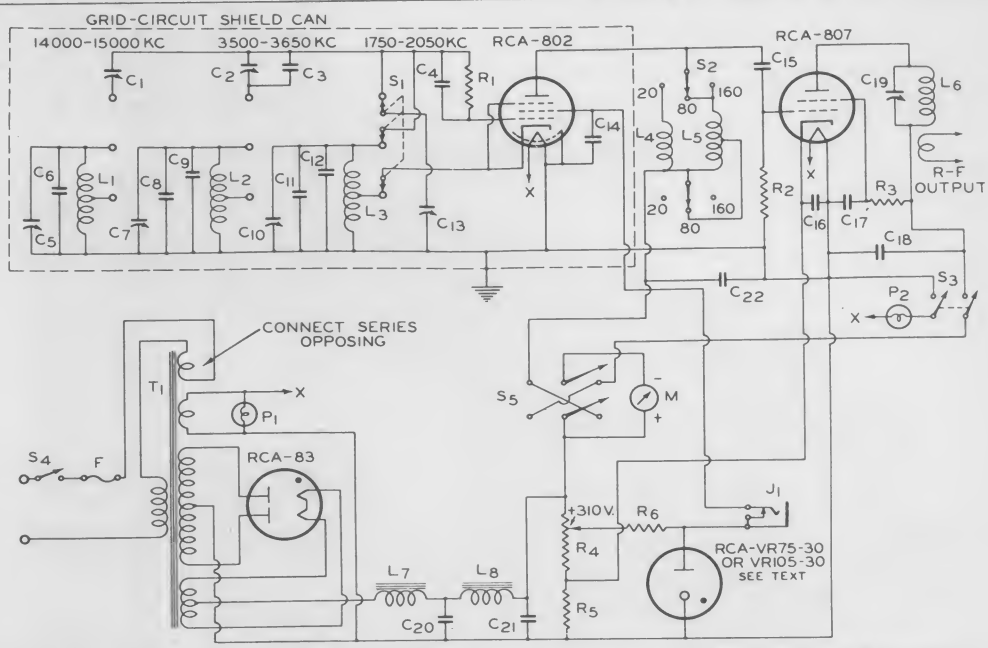
The circuit below shows that a bandswitching arrangement is provided for the 802 grid circuit and that switch S_1 cuts in three different sets of pre-tuned grid-coil, trimmer, and padder combinations for practical 5-band operation having exceptional bandspread. This switching system has proven to be remarkably stable in practice; frequent use of it does not change the calibration of the VFO more than a few cycles. The lowest L/C ratio consistent with reasonable efficiency is used on all bands.

Lowest frequency chosen for use in the grid circuit of the 802 just takes in the low-frequency edge of the 160-meter band. Originally it was considered a possibility to use a fundamental frequency range lying within the standard broadcast band, but this was quickly dropped because of the ever-present possibility of causing interference in nearby broadcast receivers through direct pick-up.

160- and 80-Meter Operation

When 160- or 80-meter output is desired from the VFO, the 802 grid circuit is tuned to 160 meters (1750 to 2050 kc) by means of C_{10}, C_{11}, C_{12}-C_{13}, and L_3. C_{11} and C_{12} are zero-temperature-coefficient condensers. The plate circuit of the 802 is designed to resonate broadly on either 160 or 80 meters by means of a tapped coil L_5, which makes it possible to short out a portion of the inductance by means of switch S_2 for 80-meter operation. A separate coil L_4 is used for 20-meter output, which also is selected by means of S_2. This system of broadly tuning the plate circuit is similar in principle to the use of the untuned grid coil in the famous TNT oscillator circuit. Primary purpose of the broadly self-resonant plate circuit is to eliminate a tuning control. Secondary benefit is that it eliminates apparent reaction on the oscillator frequency caused by normal tuning adjustments in the oscillator plate circuit. While it is possible to use an ordinary r-f choke in the 802 plate circuit, L_4 and L_5 constructed in accordance with the specifications given in the legend of the circuit provide greater useful output and higher circuit efficiency. Output from the 802 is capacitatively coupled to the 807 stage. Power output from the 807 at the desired frequency is dependent on the resonant frequency of

(*Continued on page 3, column 1*)



C_1, C_2, C_5, C_7, C_{10} = 140 $\mu\mu$f air trimmers (Hammarlund APC-140).
C_3, C_6 = 150 $\mu\mu$f zero-temperature coefficient. (Centralab).
C_4, C_{15} = 250 $\mu\mu$f mica.
C_8, C_{11} = 350 $\mu\mu$f. zero-temperature coefficient.
C_9 = 250 $\mu\mu$f. zero-temperature coefficient.
C_{12} = 300 $\mu\mu$f. zero-temperature coefficient.
C_{13} = 40 $\mu\mu$f (min.) to 395 $\mu\mu$f (max.) main tuning condenser (Hammarlund APC-350-C).
C_{14} = 0.001 mica.
C_{16}, C_{17}, C_{18} = 0.01 μf paper, 600 v.
C_{19} = 100 $\mu\mu$f variable (Cardwell ZU-100-AS).
C_{20}, C_{21} = "8-8 μf Replacement (Cornell-Dublier #PE-B).
J_1 = Keying Jack.
L_1 = 6 turns of #16 en. wire on ½" form, winding length ⅝" in.
L_2 = 23 t. #16 en. wire on ½" form, close wound.
L_3 = 33 t. #18 DCC wire on 1" form, close wound.
L_4 = 7 t. #16 en. wire on ¾" form, winding ¾" long.
L_5 = 110 t. #30 en. wire on 1" form, tapped at 71 turns; close wound.
L_6 = B. & W. coils. (See table.)
L_7 = 8-35 henry, 200 ma. choke (Stancor C-1645).
L_8 = 20 henry, 200-ma. choke (Stancor C-1646)
P_1, P_2 = 6.3-volt pilot lights (½ inch).
R_1, R_2 = 25,000 ohms, 1 w.
R_3 = 17,500 ohms, 2 watt.
R_4 = 15,000 ohms, 50 watt slider.
R_5 = 250 ohms, 10 watt.
R_6 = 10,000 ohms, 10 watt.
S_1 = TPTT rotary ceramic switch.
S_2 = DPTT rotary switch.
S_3 = DPST toggle switch.
S_4 = SPST toggle switch.
S_5 = DPDT toggle switch.
T_1 = 600-0-600 volt, 200 ma. power transformer (Stancor P-6170).
M = 0-150 ma. 2" square meter (Triplett or Simpson).

VFO Gives 10 to 25 Watts Output

(*Continued from page 2, column 4*)

L_6 C_{19}. L_6 is of the plug-in variety.

40- and 20-Meter Operation

For 40-meter operation, S_1 is set to include the 80-meter grid circuit of the 802. This circuit includes L_2, C_2, C_3, C_7, C_8, C_9 and C_{13}. C_2 and C_3 are series padding condensers, used for bandspread over the range of 10 to 90 on the dial. S_2 is set to short out a portion of L_5 so that 80-meter output will be obtained from the 802 plate circuit. The 807 is operated as a 40-meter doubler. Power sensitivity of the 807 is so high that nearly as much output is obtained at this frequency as is obtained on the two lower frequency bands.

For 20-meter operation, S_1 and S_2 are set the same as for 40-meter operation. The 807 is operated as a frequency quadrupler. Output is still sufficient to drive a pair of 812's in push-pull to full power output on 20 meters. Bandspread on this band is approximately 2/3 that on 40 meters—which is, incidently, still real bandspread!

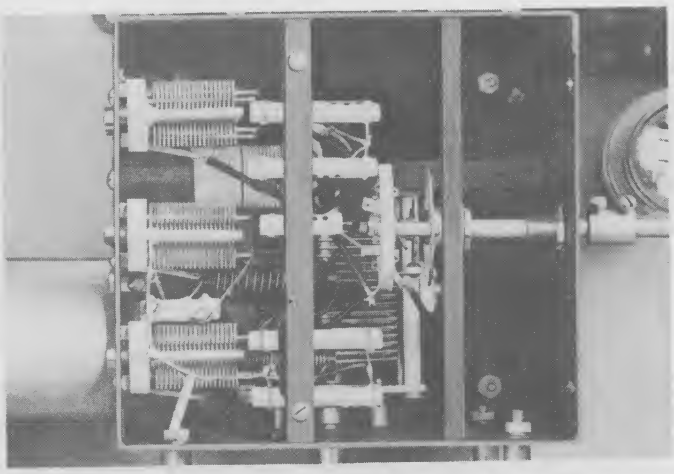
For 10-meter output, S_1 is set to include the 802 20-meter grid circuit C_1, C_5, C_6, and L_1. C_6 is a zero-temperature-coefficient condenser. S_2 is set to include L_4, tuned to resonate the 802 plate circuit broadly on 20 meters. The 807 is operated as a 10-meter doubler. Bandspread on the 10-meter band covers 10 to 90 on the ACN dial—*as much bandspread as on 40 meters.*

Frequency Stability Considerations

Sturdy mechanical construction, proper layout of components to minimize temperature rise in critical tuned circuits, high-quality parts, good voltage regulation, and the proper use of sufficient zero-temperature-coefficient condensers are the essentials of a well-performing ECO. If these important factors are considered from the start, the results are almost always bound to be satisfactory.

As can be noted from the general views of the VFO, chassis and panel design is conventional. Choice of dimensions may be left completely to individual needs. In our case, we chose a chassis, 17″ long x 10″ wide x 2″ deep, and a panel 19″ long x 8¾″ high x ⅛″ thick. This combination provided the necessary solid foundation for the job. It is interesting to note here that on final tests of the VFO, we endeavored to check the solid construction by raising one corner of the chassis about 2 inches and then dropping it. On checking the frequency shift during this torque/drop test, it was found that the frequency had varied about 30 cycles. Part of this shift was undoubtedly caused by a change in rotor position of the tuning condenser. So much then for solid chassis construction.

802 CONTROL-GRID CIRCUIT IS VITAL



The 802 grid circuit and its associated shield enclosure is the most important unit of the VFO. The five air-padders C_1, C_2, C_5, C_7 and C_{10} and the three grid coils L_1, L_2 and L_3, are mounted on the left side of the box. C_{13} and the dial mounting arrangement are seen in the center of the box. Note the position of the five zero-coefficient condensers at the top of the assembly.

Isolating Grid Circuit from Heat

A bug-bear in the design of ECO's is the problem of heat caused by normal operation of circuit components. This heat nearly always affects the frequency characteristic of the critical-tuned oscillator grid circuit and results in frequency drift. In this VFO, the effective temperature rise of the all-important grid-circuit components has been limited by grouping the grid-circuit components together in one shield can (as shown above) and by isolating this can as far as possible, from all high heat-dissipating units such as transformers, tubes, and bleeder resistors. In this case, the grid-circuit shield can is but 5½″ x 6″ x 5½″ in size. Only heat-dissipating element in the can is R_1, the 802 grid leak, which may be considered negligible since the grid current flowing through the grid circuit is unusually small. The 802 tube itself is mounted to the left of the shield can so that the tube projects horizontally away from the can (top view, page 2). Thus, the tube is well ventilated—and, what is more important, its heat does not affect the tuned circuits within the can. As added precautions to minimize the amount of heat reaching the all-important oscillator grid circuit, the 807, power transformers, rectifier tube, and filter chokes are mounted along the rear and side edges of the chassis so that they are well ventilated and are as far removed from the grid-circuit shield can as is possible.

Screen-Supply Voltage Regulated

The stability of the d-c screen voltage of an oscillator designed primarily for constant frequency output is of great importance. The use of a voltage divider for supplying a fixed value of screen voltage is of help but is not sufficient for maximum stability. For this reason, a voltage-regulator tube is used in the screen-voltage supply of the 802. It irons out effects caused by line-voltage variation and reduces oscillator hum. It is particularly helpful in eliminating chirps in the output when the oscillator is keyed—and keying *is* a feature of this VFO.

Temperature Compensation

All of the foregoing features are vital to a smooth performing and stable VFO, but the final results are incomplete without the application of temperature compensation to offset the change in frequency caused by whatever heat does reach the vital 802 grid circuit. Judicious use of zero-temperature-coefficient capacitors in parallel with the three grid-tank circuits of the oscillator do much to give the oscillator its exceptionally low frequency drift. These capacitors are not a cure-all but they do come into their own where frequency drift is due to reasonably small amounts of heat. These capacitors are mounted within the grid shield can and their installation will be covered later on.

Assembling the Vital Grid Circuit

The 802 grid circuit and its associated shield enclosure is the most important unit of the VFO and its construction and placement should be the first consideration in the construction of the instrument. The shield box is 5½″ x 6″ x 5½″ and has a removable top and bottom. The five air padders C_1, C_2, C_5, C_7, and C_{10}, and the three grid coils L_1, L_2, and L_3 are mounted on the left side of the box. Dimensions of L_1, L_2, and L_3 are given in the circuit legend on page 2. The coils are mounted end-on by means of 6-32 spade lugs. C_{13}, the main tuning condenser, is held in place by three sets of mounting screws and studs furnished with it for front mounting. The back of C_{13} is held in place by a strip of ½″ Bakelite, 2½″ wide and 6″ long, solidly bolted to the opposite sides of the box. The zero-coefficient condensers are rigidly held between two additional Bakelite strips. These two strips should first be clamped together and drilled with holes large enough to accommodate the zero-coefficient condensers. The strips should then be separated and the condensers inserted. Since these condensers are in the form of rather fragile ceramic tubing it is suggested that they be wrapped with several turns of rubber tape to reduce the danger of cracking them. This cushioning also aids in damping any possible vibration. The Bakelite mounting strips are then clamped together and bolted to opposite sides of the grid box, as shown in the figure above. They serve a further purpose by acting as cross-braces to increase the rigidity of the box and of the parts mounted on it.

Mounting Bandswitch S_1

Bandswitch S_1 is mounted on the right side of the grid circuit shield box. It is held in place by means of a third Bakelite cross-brace. S_1 selects the critical-tuned grid circuits and its

(*Continued on page 4, column 1*)

RCA Tube Handbooks Indispensable to Engineers

(*Continued from page 1, column 2*)

Microphonic tubes, Gas-Triodes, and Gas-Tetrodes. For example, data on any particular tube type include its intended use, maximum ratings, characteristics, typical operating conditions, physical dimensions, terminal or socket connections and its most commonly used characteristic curves. These curves are plotted to easily readable scales and large enough for solving of design problems.

In addition to the above information, HB-3 Handbooks contain a valuable storehouse of general information on radio tube definitions, base dimensions, types of cathodes, conversion factors, outline drawings, resistance-coupled charts, etc. RCA All-Types Handbooks are available either in two 4-prong binders marked Vol. 1-2 and Vol. 3-4 (as illustrated) or in three 6-ring binders marked Vol. 1, Vol. 2, and Vol. 3. Subscription price for either style is $6.00, which includes cost of service for one year.

For those who require information only on receiving tube types, there is available the HB-1 Handbook which contains the first section of the HB-3. The HB-1 is available either in one 4-prong binder at $3.75, or in two 6-ring binders at $4.00. These prices include cost of service for one year. All binders of both the HB-1 and the HB-3 are furnished in black fabricord, 7⅜″ high by 5″ wide.

Prices quoted above apply only in the U. S. A. and its possessions.

All inquiries and orders for Handbooks should be sent to the Commercial Engineering Section, RCA Manufacturing Co., Inc., Harrison, N. J.

VFO Gives 10 to 25 Watts Output

(*Continued from page 3, column 4*)

importance cannot be overestimated. It should be of good quality and be designed with ceramic insulation. S_1 is controlled from the front panel by means of a short, flexible shaft which must make a right-angle bend. There is no need to be alarmed about the small amount of backlash originating in the cable because the switch contacts are spaced 30° apart. As mentioned earlier, the 802 is mounted on the lower left side of the shield can. The entire shield-can assembly with the 802 on the side, is then mounted to the chassis by means of four live-rubber washer assemblies. These washers have excellent shock-absorbing qualities. It can now be seen that with this arrangement, mounting the tuning dial rigidly to the panel in usual constructional practice would require the use of a flexible coupling between dial and C_{13} to preserve the mechanical shock-proof qualities of the live-rubber mountings. But the use of a flexible coupling is undesirable because it will introduce backlash and moreover may not have an exact 1:1 ratio should the shield box become displaced slightly from its normal position.

Tuning Dial is Important

To overcome the above effect, a National ACN was chosen for the tuning control. It has remarkable freedom from backlash and includes a built-in, semi-flexible coupling device which compensates for minor mis-alignment of dial or condenser. The ACN dial permits mounting of the tuning control directly on the grid-circuit shield can so that the whole assembly including the dial is free to float. (While on the subject of backlash, it might be timely to touch on the subject of an insidious type of backlash which shows up in some types of double-bearing condensers. This backlash is caused by the tendency of the back end of the rotor shaft to hop up and down in its bearing when the rotor is "inched" first one way and then the other. It is well to look very closely for this defect in a condenser used as the grid-circuit tuning control in *any* ECO. This defect, of course, will cause no trouble in amplifier circuits.)

The white cardboard dial itself is fastened to a sheet-metal backing plate which in turn is mounted solidly to the shield can by means of four ⅜" metal studs. These studs are made about 1" long to permit the dial to be placed about ¼" in front of the main VFO panel and the grid-circuit shield box about ⅝" behind the VFO panel. Clearance holes are made in the VFO panel to allow for suitable clearance of the studs. The studs are drilled and tapped at each end for 6-32 or 8-32 screws. The dial-backing plate is fastened to the studs by means of countersunk screws to permit a snug fit of the dial against the plate. Four ⅝" holes are drilled through the panel behind the dial to clear the mounting studs, and a 2½" hole should be made around the condenser shaft center to clear the dial mechanism. With this arrangement it is possible to bump the chassis or operating table without causing appreciable frequency wobble.

In the actual assembly and wiring of the grid shield box, the layout of the large parts should first be determined. Then the ACN dial and C_{13} should be mounted on the shield box and the positions of the panel holes behind the dial determined. The bottom cover of the can may be mounted by means of the four rubber washer assemblies. The dial and C_{13} should next be removed from the shield can and with both covers removed from the can, all holes should be drilled, all parts mounted, and all wiring completed. A small "pencil" type soldering iron will prove useful in the wiring of this unit.

Long, flexible leads should be soldered to the 802 socket while the shield can is out in the open. These leads can then be threaded through grommeted holes in the bottom shield cover and the chassis before replacing the shield can of the tube. Several inches of slack should be left in these power leads so that the grid-circuit shield box can be tipped up on edge for servicing later, if desired. A small feed-through insulator is used to run the 802 plate lead through the chassis. The 802 plate coils L_4 and L_5 and bandswitch S_2 are mounted beneath the chassis for added shielding. Dimensions of L_4 and L_5 are given in the legend of the circuit on page 2. S_2 is a double-pole, triple-throw rotary switch.

Laying Out the 807 Stage

As can be seen from the illustrations, layout of the 807 is comparatively simple. Plug-in plate coils are used in this stage. The socket for the plate coil, L_6, is mounted above the chassis for convenience in changing coils. Tuning condenser C_{19} is mounted on a bracket beneath the chassis and is connected by a long insulated extension shaft to a control knob on the front panel. The 807 is capacitatively coupled to the 802 through C_{15}. The plate lead of the tube is run through a feed-through insulator to the tank circuit below the chassis.

Power Supply is Simple

An inexpensive 600-0-600 volt power transformer and an 83 mercury-vapor rectifier supply all voltages for the VFO. A double-section filter system is used. L_7 is of the swinging type. L_8 is a standard fixed type. Regulation of the power supply is excellent. The 83 with its low voltage drop, L_7 and L_8 with their reasonably low d-c resistance, and the swinging properties of L_7 all tend to compensate for variations in load. Output ripple voltage of the supply is very low. This fact is important in any ECO.

At this point it should be called to the attention of the constructor that the extra 6.3-volt filament winding on the power transformer is connected in series with the primary of the transformer so that the high secondary voltage is reduced to 550-0-550. This is done to prevent application of excessive voltage to the 83. A tap on bleeder resistor R_4 permits adjustment of the VR-75-30 voltage regulator tube so that it draws about 25 ma. under key-up conditions. A d-c milliammeter may be inserted at "x" during this screen-circuit voltage adjustment. In actual tests, it has been found that use of a VR-75-30 gives more 807 output from 160 to 20 meters than when the 802 screen is operated at a higher voltage with a VR-105-30. Moreover, the use of the higher screen voltage doubles the 802 plate current and increases frequency drift during warm-up periods.

Aligning and Calibrating

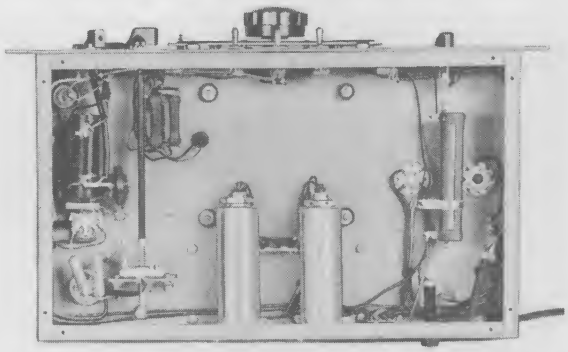
This VFO may be considered a precision instrument and as such is deserving of accurate calibration. A frequency standard, such as the RCA type TMV-133A Crystal Oscillator,

(*Continued on page 5, column 1*)

DID YOU KNOW THAT . . .

WCFT, the schooner Yankee, maintained round - the - world communication using an RCA-803 325-watt transmitting pentode during its cruise in 1939-1941? Circuit used was an E.C.O. on 18, 24, 27, 36 and 600 meters.

BOTTOM VIEW OF DELUXE 5-BAND VFO



All parts are mounted on a 17" x 10" x 2" chassis. Proper layout of components, high-quality parts, good voltage regulation, and correct use of zero-temperature coefficient condensers, contribute to the remarkable performance of this VFO. The 802 plate coils L_4 and L_5 are located in the upper left corner. L_5 consists of 110 close-wound turns of #30 enamelled wire on a 1" form and tapped at 71 turns. L_4 consists of 7 turns of #16 enamelled wire on a ¾" form. Winding is ¾" long.

GIANT BAND-SPREAD DIAL PERMITS ACCURATE RESET

Bandspread extends from approximately 120° on 20 and 80 meters, to 145° on 10 meters. Tests show that it is practical to reset the frequency within a few hundred cycles of a marked point on 80 meters. For this reason, no provision was made for inclusion of crystals for spot-frequency operation.

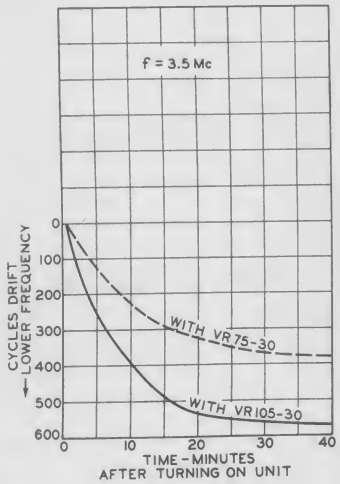
VFO Gives 10 to 25 Watts Output

(*Continued from page 4, column 4*)

is invaluable for aligning and calibrating it. The TMV-133A provides usuable harmonics every 100 kc. up to 30 Mc. In lieu of such a frequency standard, an accurately calibrated receiver, or a receiver operated in conjunction with a well-built, home-constructed 100-kc. oscillator that is calibrated against a local broadcast station, will be satisfactory.

First, the 802 grid circuit should be adjusted. Plate and screen voltage of the 807 should be removed by leaving S_3 open. Set S_1 to "160" and adjust C_{10} with a screwdriver so that the oscillator output tunes exactly to 1900 kc. with C_{13} set at "50" on the dial. If the band will not center, use a larger or smaller value of C_{11}. Should the dial not cover the complete range from 1750 to 2050 kc., remove one or two turns from L_3 and add to C_{10}, C_{11} or C_{12} as needed. This completes the calibration for 160 meters and since this grid tank circuit is also used on 80 meters by doubling in the plate circuit, the calibration is also completed for 80 meters.

Second operation is to calibrate the 802 grid circuit operation on 40 meters. Set S_2 to the "80" position and adjust C_7 so that the second harmonic of the oscillator tunes exactly to 7300 with C_{13} set at "10" (near minimum). Next, turn C_{13} to read "90" on the dial (near maximum) and adjust C_2 so that the oscillator just hits 3500 kc. This completes the calibration for 40 meter, and since the 80-meter grid tank circuit is also used by quadrupling in the plate circuit, the calibration is also completed for 20-meter operation.



VFO Frequency Drift Characteristics

Third operation is to calibrate the 802 grid circuit for operation on 10 meters. Set S_2 to "20" and adjust C_5 so the second harmonic of the oscillator tunes exactly to 28,000 kc. with C_{13} set at "90." Output on 10 meters is obtained by doubling in the 802 plate circuit.

After the 802 grid circuit has been aligned, plate coil L_5 should be adjusted to give 3 to 5 ma. grid current when S_1 and S_2 together are set at "80" or "160." L_4 should then be adjusted to give 1 to 2 ma. when S_1 and S_2 together are set at "20." Grid current can be measured by opening the ground end of R_2 and inserting an 0-5 or 0-10 d-c milliammeter in the 807 grid circuit. The opened end of R_2 should be by-passed for r.f. to the chassis during the measurement to maintain a short r-f grid circuit return. As discussed earlier, the 807 is protected during key-up conditions by the semi-fixed bias voltage provided by the sum of the 807 cathode current and the bleeder current developed across R_5. Dimensions for L_6 are given in Table I, page 6.

Keying is Crisp and Clean-Cut

Keying of this VFO is done in the oscillator circuit for break-in operation. Oscillation is completely cut off by keying the 802 screen voltage, between the 802 and the voltage-regulator tube. It is important to note that keying of the screen voltage should not be accomplished between the voltage-regulator tube and the negative side of the voltage supply as shown by "X" in the circuit for this method will produce very bad keying transients. With the circuit shown, keying is clean and crisp and any slight key clicks resulting from making and breaking this low-current circuit can readily be eliminated by means of a simple resistance-capacitance filter across J_1 for normally closed circuit. Plug for J_1 may be wired to a key, switch, or relay contact, as desired. For listening, S_3 and J_1 are normally open. To "spot" a desired station, close J_1 and swing C_{13} to zero beat with the desired incoming signal. Then flip S_3 to "on" when ready to transmit.

How VFO Performs

The curves on this page show the number of cycles the 802 control grid circuit drifts from a cold start when operating at 3.5 Mc. Note that, when using a VR-75-30 regulator in the screen circuit of the 802, the overall drift is less than 400 cycles and that practically all of this drift occurs within the first 30 minutes of operation. Moreover, after the first 10 minutes of operation, the oscillator drifts only about 150 cycles. When a VR-105-30 is used in place of the VR-75-30, the drift increases, but the results are still exceptional. Various tests were made to check mechanical and electrical stability. When the oscillator grid box was jarred, bumped or twisted, it was found that the signal always returned to within about ±5 cycles of its original frequency. It was found that wrapping the bulb of the 802 bulb with several turns of rubber tape aided stability by preventing tube movement within its shield can. A test was made on the practicability of using the band-switching 802 grid circuit. S_1 was rapidly flipped over 30 times in succession. On checking the frequency change after this check, it was found that the total frequency drift was less than 10 cycles! In a careful check of the stability and accuracy of the instrument, it was found that the oscillator could be reset to a few parts in a hundred thousand. Measured power output from the 807 was approximately 25 watts on 160 meters, 20 watts on 80 meters, 15 watts on 40 and 20 meters and 5 watts on 10 meters. Either capacitative or link coupling may be used to the following stage. When capacitative coupling is used, the length of the interstage coupling lead should be as short as possible. When link coupling is used, losses incurred in the impedance line are not appreciable up to approximately four feet. If it is desired to drive a beam tube, such as an 828 or an 813, it is recommended that a potentiometer be used in place of the 807 screen series resistor in order to reduce the 807 output by controlling the 807 screen voltage.

From the foregoing description, it can readily be seen that this VFO can be built as a precision instrument. As such, it should be treated carefully to provide the constructor with the utmost in performance. It will save the operator invaluable time in station operation and add greatly to the ease and pleasure of getting the most out of every QSO. The author wishes to express his sincere appreciation to Messrs. A. G. Nekut, E. E. Spitzer, and R. S. Burnap of the Radiotron Division for their invaluable assistance in the designing, building and testing of this unusual instrument.

W6RTO BUILDS 807 RIG IN VIRTUAL SHOW WINDOW

The $5.00 prize goes to F. L. Moore, of Moffett Field, Calif., for a picture of his most novel transmitter. The rig uses a 6L6 crystal oscillator and two 807's in parallel at 120 watts input. It is built in one complete unit with self-contained power supply and an antenna coupler to match any type of radiator. No need for further details, we see right through it (??)

Appendix

Tuning-condenser values for an ECO designed to have approximately 100% bandspread may be calculated as follows:

For a given total maximum capacitance (C max.), the net capacitance variation (K) required to give 100% coverage from a low-frequency limit (f low) to a high-frequency limit (f high) can be calculated from the following relation:

$$K = C_{max}\left[1-\left(\frac{f_{low}}{f_{high}}\right)^2\right]$$

As an example, for the "160" grid-circuit position, assume C_{max} = 1185 $\mu\mu$f, f_{low} = 1750 kc., and f_{high} = 2050 kc. Therefore,

$$K = 1185\left[1-\left(\frac{1750}{2050}\right)^2\right] = 324\ \mu\mu f$$

For a variable condenser having a total maximum capacitance of 395 $\mu\mu$f, the total shunt padder capacitance should be 1185 – 395 = 790 $\mu\mu$f which equals the sum of C_{10}, C_{11}, C_{12}, and stray capacitances. See Fig. 2.

If, for example, a tuning condenser having a maximum capacitance of (say) 500 $\mu\mu$f, and a minimum capacitance of (say) 50 $\mu\mu$f is used, the total K is 500 – 50 $\mu\mu$f = K. For calculation purposes, K can be treated approximately as a fixed capacitance. Using the well-known series-condenser relations we obtain:

(*Continued on page 6, column 1*)

BOOK OF THE HOUR

The RCA GUIDE for Transmitting Tubes is the finest and most complete engineering and amateur guide on transmitting tubes ever published by RCA. It contains comprehensive data on 69 RCA Air-Cooled Types including the 815, 816, 8000, 8001, 8003, 8005, 9001, 9002, and 9003. Don't be without this book another day.

HAM TIPS from RCA

VFO Gives 10 to 25 Watts Output

(*Continued from page 5, column 4*)

$$\frac{1}{C_{series}} = \frac{1}{C_{net}} - \frac{1}{C_{tuning}}$$

$$\frac{1}{C_{series}} = \frac{1}{-324} - \frac{1}{450}$$

$$C_{series} = 1340\ \mu\mu f$$

This 1010 $\mu\mu f$ capacitance may be made up of several zero-coefficient condensers in parallel with each other and with a small adjustable padder.

The above calculations are, of course, complicated by the presence of stray tube and circuit capacitances. However, by carefully estimating and allowing for stray tube and circuit capacitances, it is possible to come out fairly closely. Use of partially adjustable padders will make up for reasonable errors. It should be mentioned in passing that, in practice, more error results from inaccurate coil-size calculations, than from inaccurate stray-capacitance allowances.

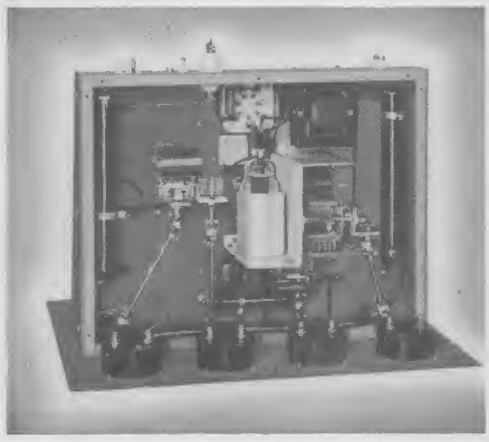
READING LIST

1. A Stabilized Variable-Frequency Oscillator, Brown, July 1940 QST.
2. E.C.O. Exciter with 20 Watts Output, Mix, October 1940 QST.
3. An Answer to the ECO Problem, Perrine, September 1939 QST.
4. An E.C.O., 1940 Model, Southworth, November 1940 QST.
5. Notes on ECO Drift, June 1940 QST, p. 68.
6. VFO for Transmitter, Griffin, November 1938 QST.
7. Refinements in Combination Exciters, Ferril, October 1938 QST.
8. A Five-Band Switching Exciter, Kinn, September 1938 QST.
9. Improving ECO Stability, August 1938 QST, p. 28.
10. Look for Me On-Kc., Tilton and Browning, July 1938, QST.
11. Combined VFO and 100-kc. Standard, Stephens, March 1940 Radio.
12. Standard Frequency Crystal Unit, January 1939, QST.
13. A 50-, 100- and 1000-KC. Oscillator, September 1941, QST, p. 32.
14. Let's Talk E.C.O., Stiles and Blair, August 1941 QST.
15. A Transmitter Frequency Control Unit with Three-Band Output, Shuart, June 1941 QST.
16. An Improved ECO, Metcalf, May 1941 QST.
17. A Gang-Tuned V.F.O., Goodman, March 1941 QST.
18. The "Variarm 150," Rice, January 1941 QST.

TABLE I
807 PLATE TANK COIL (L_6)

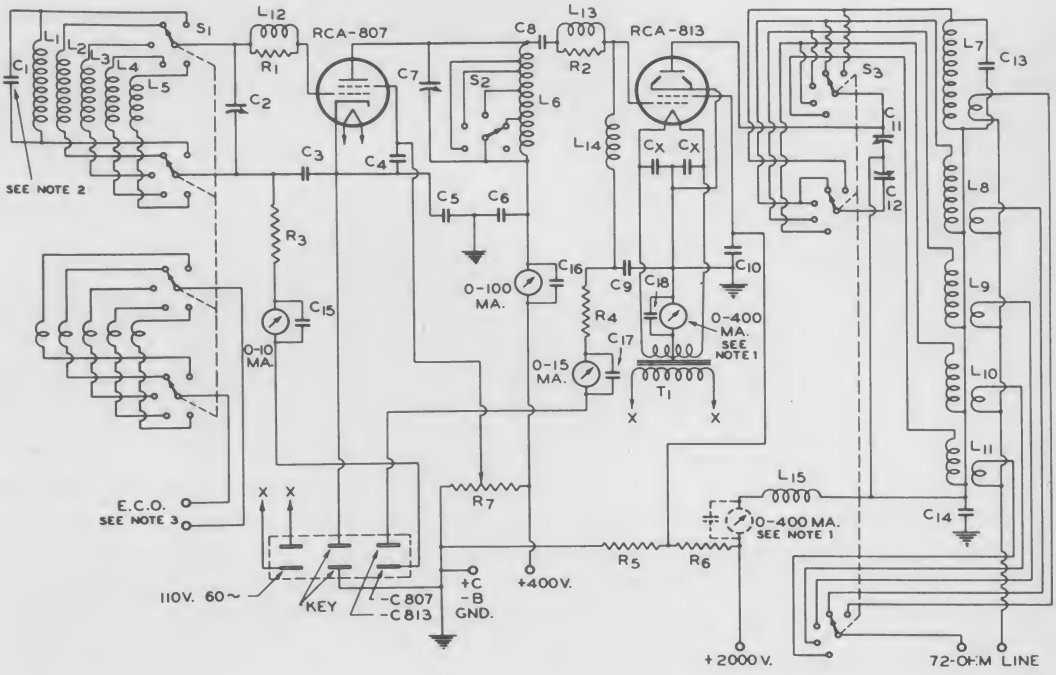
Output Band Meters	Diameter inches	Length inches	No. Turns	End Link Turns
160	1⅜	1½	45	3
80	1⅜	1⅞	32	3
40	1⅜	1¾	18	2
20	1¾	2¾	13	2
10	1¾	2	8	2

W3DGP 807-813 RIG A MASTERPIECE OF DESIGN AND CONSTRUCTION



This transmitter deserves special commendation. It was built with careful thought and with a mind to reliability and performance. It consists of an 807 buffer/multiplier stage driving an 813 final. The 807 may be driven by an external crystal oscillator or by a good ECO. Approximately 3 watts of input is all that is necessary for 807 excitation on any frequency. The buffer/multiplier stage is ingeniously located beneath the chassis, the final above it. All circuits are band-switching. Output efficiency of the final is approximately 70% on 10 meters and 75% on 20, 40, 80, and 160 meters.

SCHEMATIC CIRCUIT DIAGRAM



W3DGP 807/813 BEAM POWER TUBE TRANSMITTER

Output efficiency, 70 to 75% on 5 bands

C_1 = 50 $\mu\mu f$ Mica 1000 V.
C_2 = 50 $\mu\mu f$ 0.020" plate spacing Cardwell ZR50AS.
C_3 = C_4, C_5, C_6, C_9, Cx 0.01 μf 600 V.
C_{10} = 0.01 μf 2000 V.
C_{11} = 18 $\mu\mu f$ two section single ended condenser Cardwell.
C_{12} = 75 $\mu\mu f$ Special XC-75-18-XD.
C_{13} = 50 $\mu\mu f$ Cardwell JD-50-OS
C_{14} = 0.002 μf.
C_7 = 100 $\mu\mu f$ .020 spacing Cardwell Trim-Air ZO-100-As.
C_8 = 50 $\mu\mu f$ .050 spacing Cardwell Trim-Air EO-50-FS.

R_1 = 100-ohms 2W.
R_2 = 100-ohms 2W.
R_3 = 20,000 Ohms 2 W.
R_4 = 10,000 Ohms 2 W.
R_5 = 20,000 Ohms 100 W.
R_6 = 40,000 Ohms 200 W.
R_7 = 25,000 Ohms 50 W.
RFC_1, RFC_2 = 8 to 10 turns #16 DDC wound on R_1 and R_2.
RFC_3 = R. F. choke National R100.
RFC_4 = Ohmite 160-meter choke.
L_1 = L_2, L_3, L_4, L_5 B&W type BTEL turret 160-10 meters.

L_6 = B&W type 2A band-switch coils.
L_7 = Special final tank coils.
Sw_1 = BTEL turret switch.
Sw_2 = 2A band switch B&W.
Sw_3 = H&K three section switch.
T_1 = 10-V, 10-Amp. Filament transformer.
T_2 = (Not shown) 6.3 V. 1 Amp. 807 filament. (center tap ungrounded.)

NOTE: The small padding condenser shown across the 160-meter turret coil is for elimination of any resonance absorption in this particular coil on 10 and 20 meters. Capacity of this padder is 50 $\mu\mu f$ and a mica-type receiving condenser will be satisfactory.

The license extended to the purchaser of tubes appears in the License Notice accompanying them. Information contained herein is furnished without assuming any obligation.

Printed in U.S.A.

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RCA

Ham Tips

PUBLISHED - IN - THE - INTEREST - OF - RADIO - AMATEURS - AND - EXPERIMENTERS

VOLUME VI, No. 1 EDITORIAL OFFICES, RCA, HARRISON, N. J. JULY, 1946

SMALL OSCILLATOR DOES BANG-UP JOB ON 2 METER BAND

Grid-Stabilized Circuit Uses RCA-815 Tube

By J. H. Owens, W3ASZ/2

The revival of Ham Radio via a temporary allocation at 2½ meters put most of the uhf boys back in business and gave many of the low-frequency fellows their first taste of vhf work. But the venture was short lived, as the band was quickly shifted down to 2 meters.

Then, a great many Amateurs found that it's a long way from 116 Mc to 144 Mc. Mediocre 2½-meter design techniques did not work well on 2 meters. Likewise, many tubes that performed excellently on the lower frequency band were found to be little better than crutches at 144 Mc. An exception to this is the RCA-815 dual beam power tube. It is the purpose of this article to show how easy it is to use this tube in a nifty little oscillator-transmitter that will bring in complimentary reports consistently.

Furthermore, the circuit is not sensitive to minor changes in mechanical design—if the fundamentals are observed, the RCA-815 will perform nicely in a wide variety of arrangements.

Grid Circuit Important

The primary factor that makes possible the excellent performance of this transmitter is the design of the grid circuit. In a TPTG oscillator, it is the duty of the grid tank to see that the grids receive ample driving power with low losses, and to assert a definite controlling effect upon the frequency of oscillation. These properties are fairly simple to build into low-frequency oscillators, but at 144 Mc, obtaining them can be very difficult because of such factors as, (1) the input resistance of a tube is low enough to load down the grid tank, and (2) the input capacitance of a tube is high enough to resonate a couple of inches of wire to a frequency lower than 144 Mc.

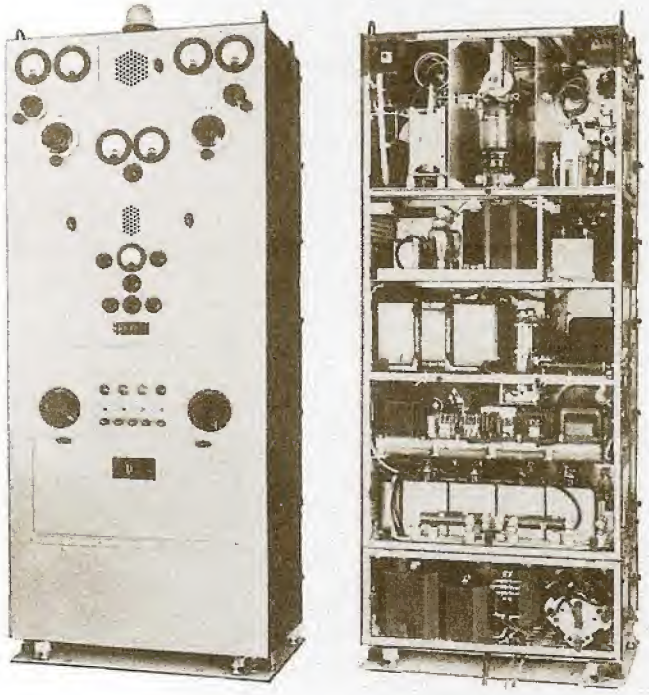
The solution to the problem turned out to be rather simple and straight-forward, once the problem

(Continued on Page 2, Column 1)

"HAM TIPS" ANNOUNCES CONTEST FOR RCA TUBE EQUIPPED RIGS

Scheduled for each issue of HAM TIPS is a photograph and description of an outstanding Ham rig that is 100% RCA tube equipped. Send your photos, name, and Amateur call letters to the Editor of HAM TIPS, RCA Tube Department, Harrison, New Jersey. If you win, you will receive a check for $10.00, and your rig will be pictured in a forthcoming issue. All entry material becomes the property of RCA, and cannot be returned.

W2BFB WINS THE OPENING PRIZE



Congratulations and ten bucks go to James N. Whitaker, 93 Shepard Avenue, Englewood, New Jersey for the above photographs.

The front panel picture is very professional, but the rear view proves that Jim Whitaker is a regular cramming, jamming, space-conserving, ingenious Ham.

The final amplifier uses a pair of RCA 833-A's, driven by an RCA 4E27/8001 and modulated by a pair of RCA 810's. Power is furnished by four RCA 872A's in a bridge circuit. Jim, who is engineer in charge of Transmitter Division, Hammarlund Manufacturing Company, states "The 833A's will take 2500 watts input at 28 Mcs with a plate circuit efficiency of more than 82%."

Too bad he can't use that power on the air!

RF CHOKE FORMULA HELPS MAKE COIL FABRICATION EASY

Choke "Know How" Valuable in Rig Construction

By J. G. Beard
RCA Engineering Products Dept.

Many amateurs who are building new transmitters or receivers for use on the vhf bands will need rf chokes. The best rf choke is one that has the greatest amount of reactance for a given value of resistance. This requirement can be met by the use of a length of wire equal to one quarter of the operating wave length.

The wire should be wound on a small mandrel of less than ½" diameter, and the mandrel should then be removed. The coil should be stretched a little so that adjacent turns do not touch. Use of #18 or larger wire will make the coil self-supporting and rigid.

Formula Applications

The following table gives the correct length of wire for operation in the bands shown.

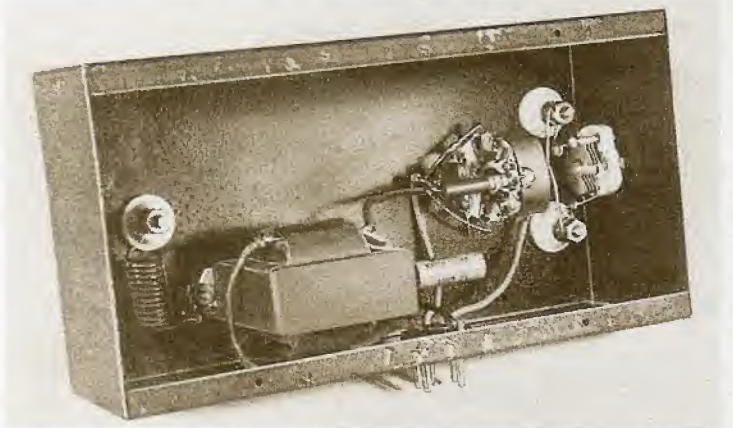
Freq. Band	*Length of Wire*
50 Mc— 54 Mc	56.6 inches
144 Mc—148 Mc	20 "
235 Mc—240 Mc	12.5 "

For other bands the required length of wire in inches can be determined by dividing 2953 by the frequency in megacycles. As long as the diameter of the choke coil is kept small, the formula gives a length of wire which is quite accurate.

Choke coils should be positioned in the apparatus so that they do not couple to each other or to tank circuits. They should also be mounted at right angles to the chassis, because mounting them parallel with the chassis has the undesirable effect of increasing their distributed capacitance. Hot and cold end connections should be kept as short as possible.

Quarter-wave chokes, for most effective operation, should have their "cold" ends by-passed with mica or air-dialectric capacitors having short leads. Coils made and utilized in accordance with these design specifications are very efficient in choking off RF.

EASY-TO-BUILD TRANSMITTER



Bottom view photograph of Simple Oscillator, showing RF at one end and AF at the other, with plenty of space for meters and jacks.

SMALL OSCILLATOR

(Continued from Page 1, Column 1)

had been fully subjected to good reasoning. On a step-by-step basis, the answers popped up, as follows: (1) Rather than rely on or add to the tube's small grid-plate capacitance for feedback, it was decided to "over-neutralize" this small value of residual grid-plate capacitance.

Over-neutralization, accomplished by adding external capacitance from #1 plate to the #2 grid circuit, and external capacitance from #2 plate to the #1 grid circuit, provides better phase relationship between the rf currents in the grid and plate circuits than does the normal feedback path across the tube's grid-plate capacitance. (2) In order to give the grid some control over frequency, it is necessary to put a great deal of energy into the grid tank. This is done by using a large amount of "over-neutralizing" capacitance—far more than is necessary to sustain oscillations. With a low-loss grid tank, this design costs practically nothing. Because there is so much energy in the grid tank, the rf voltage is high, and the grids can be tapped far down to a low-impedance point where they will exert only a small loading effect. This permits good Q, and an appreciable control over the frequency of operation. The end result is improved frequency stability.

Design Factors

The grid tank starts with a piece of copper strap, ½ inch wide and 3 inches long, soldered directly to the grid terminals of the tube socket. The next section of the grid tank consists of two 3-inch pieces of #14 wire criss-crossed and connected between the socket grid terminals and the feed-through insulators. A five-plate midget condenser is connected across the feed-through insulators at this point. The feed-through insulators are the next section of the grid tank. On top of the chassis is the remainder of the grid tank which consists of two feed-back plates, ½ inch wide and 2 inches long, soldered to 2-inch pieces of #12 wire which are in turn mounted on the feed-through insulators.

The second design factor responsible for the overall simplicity and performance of this rig is the plate tank circuit. There, a strap has been used in place of the usual rods. The advantages are several, e.g., (1) the surface area of a ½"-strap is greater than that of the popular ¼"-copper tubing, and (2) the copper straps are trimmed down to a width of ¼" at their ends and soldered directly to the plate clips, eliminating the losses usually suffered in flexible leads at this point, and (3) the shorting bar and the variable resistance it inserts in the rf circuit is eliminated.

Tuning Is Simple

Tuning of the linear plate tank circuit is accomplished merely by varying the spacing between the elements. When the straps are farthest apart, their inductance is highest, but when they are spaced closely, their inductance goes down. Tuning is therefore a very simple process—squeeze or spread the straps and the frequency goes up and down. It's as easy as that. To prevent any strain being transferred to the tubes' plate caps when the tank is tuned, the two sections are supported by a pillar-type ceramic stand-off insulator at a point 1¼ inches from the open end.

The modulation transformer is novel, though perhaps not an original idea. Use is made of a universal output transformer of the open-mounting type. It is first disassembled, and the core separated into its "E" and "I" sections. The transformer is then reassembled, but the "I" section is spaced from

(Continued on Page 3, Column 3)

PRICES DOWN AND RATINGS UP ON POPULAR HAM TYPE RCA-813

Production Savings on Other Tubes Passed on to Amateur

The popularity of the RCA-813 promises to skyrocket to new heights as a result of a new low price of $14.50 and the assignment to it of ICAS ratings. In Class C telephony, it will now take 200 ma plate current at 2000 volts, and in Class C telegraphy it will take 220 ma at 2250 volts. Two 813's will take 440 ma—virtually a kilowatt for $29.00.

Other factors that have contributed to Amateur acceptance of the 813 are (1) full input to 30 megacycles, (2) operation without neutralization from "Ten" to "Seventy-Five," (3) low driving power, and (4) good linearity with simultaneous modulation of the plate and screen. Here is the answer to your requirements for a high power final. More details of this in the next issue of HAM TIPS.

"Know-How" Lowers Tube Costs

Quite a few Amateur types have gotten a break in an RCA tube general price revision which was recently authorized by the OPA. Although the trend is upward, wartime mass production methods have provided a cost reduction in some cases, and this saving is passed on to our friends, the Hams. In the following listing, note particularly the 826, 829-B, 832-A, 833-A and the 8025-A.

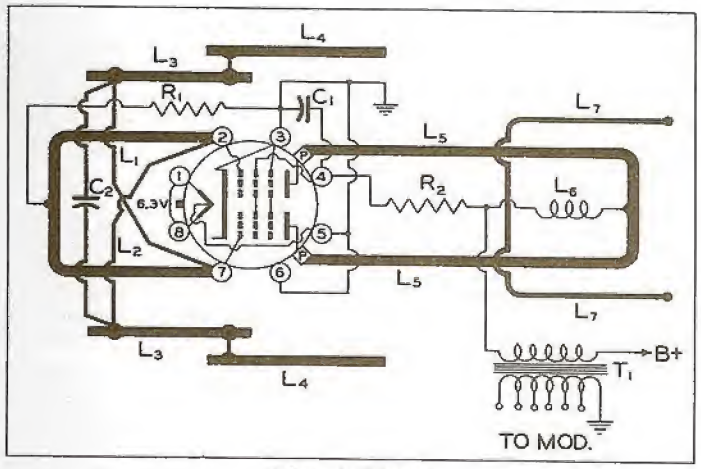
Type	Amateur Net Old Price	Amateur Net New Price
2C43	$10.25	$9.50
5R4-GY	1.00	1.29
6F4	5.10	5.48
6J4	4.50	4.84
805	11.00	9.00
807	1.95	2.30
809	2.50	3.50
810	13.50	12.50
813	18.00	14.50
815	4.50	6.25
816	1.00	1.25
826	12.00	9.25
829-B	17.00	14.75
832-A	13.00	10.47
8025-A	11.00	9.25

HAM TIPS SERVICE FOR RIG QUERIES

That "brain twister" which every Amateur runs into at one time or other can now be submitted for solution to HAM TIPS' new question and answer service. Problems of general interest will be published in a monthly column to be conducted by Captain John L. Reinartz, USNR, back with RCA after seven years of military duty.

Well known to Hamdom for his long participation in amateur radio activities, his accomplishments include the design of the Reinartz receiver, the technical work "Reflection of Short Waves," published in 1925, and his communications work with the Byrd Arctic Expedition.

Readers are encouraged to send in problems concerning tubes and their application to RCA's Commercial Engineering Section, Harrison, New Jersey, which will act as a clearing house between Captain Reinartz and the editors of HAM TIPS. Each inquiry—whether it is published or not—will receive the attention of RCA engineering experts.



Schematic Diagram.

RCA-807 IS "LITTLE MAGICIAN" TO HAMS USING VERSATILE TUBE

Conceived and developed by RCA engineers, the 807 was announced to the world away back in 1936. Now ten years old, the 807 is still the most popular type in its class. At the recent Framingham Ham Fest, a survey was conducted, which revealed that the tube has even wider acceptance than we suspected—it was found to be the most popular type for final-amplifier use, by a substantial margin over the nearest competing type, which incidentally was also of RCA origin.

The 807's versatility is probably the biggest single contributing factor to its popularity. It is an excellent crystal oscillator and electron-coupled oscillator; it is unparalled for frequency doubler and tripler service; it will operate as a "straight-through" amplifier without neutralization, and it can be amplitude-modulated as easily as a triode—by simply connecting the screen dropping resistor to the modulation transformer together with the plate lead.

The high power-sensitivity of the 807, which is one of its desirable features, makes it require more careful handling than a low-gain triode. The plate and grid circuits must be fully isolated from one another, and an external shield should be used which extends up to the bottom of the plate element. In addition, a 0.005 μf mica capacitor should be installed directly on the tube socket terminals between screen-grid and cathode. One side of the filament should be grounded, and the other side should be by-passed to the chassis right at the socket, or in case a center-tapped filament transformer is used, both of the filament terminals should be by-passed at the socket to the chassis with 0.005 μf mica capacitors. If these few precautions are taken, no erratic behavior need be anticipated.

No wonder it is called the "Little Magician."

RCA - 807

THREE NEW TUBES JOIN RCA FAMILY

The 2BP1 and 2BP11 are the latest additions to RCA's line of cathode ray tubes. Both are 2-inch tubes, and are alike except for the character of their screens. The 2BP1 produces green fluorescence with medium persistence, and the 2BP11 gives bluish fluorescence with short persistence.

Compared with older types such as the 902A and 2AP1-A, the new tubes feature higher deflection sensitivity, sharper and more uniform focus, better contrast, greater light output, less current drain, and a separate base-pin connection for each electrode. With slight circuit modifications, they can be used in equipment built around the earlier types.

The 2BP1 was designed especially for direct viewing service in oscillographs, modulation monitors, and other visual indicators. The 2BP11, with its highly actinic trace, is intended primarily for photographic work.

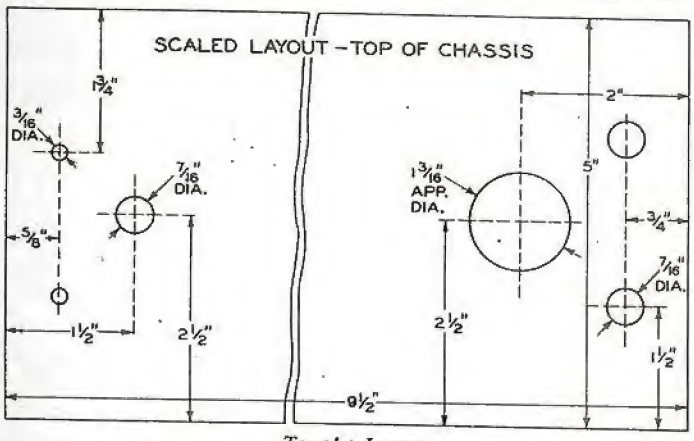
The Amateur Net price for the 2BP1 is $8.75; for the 2BP11 it is $10.00.

A Triode for 2 Meters

The RCA-6C24 is a new external anode power triode that will interest progressive Amateurs who contemplate putting high power on the 6- and 2-meter bands. In Class C telephony service it will take a kilowatt at 148 megacycles.

Designed especially for FM and television, the 6C24 has low interelectrode capacitances, low lead inductance, center-tapped filament, small size, and efficient copper radiator for forced-air cooling. The price is $45.00 net to the Amateur.

For further information on these and other RCA tubes, see your nearest RCA power tube distributor or write to the RCA Commercial Engineering Section, Harrison, N. J.



Templet Layout.

SMALL OSCILLATOR

(Continued from Page 2, Column 2)

the "E" section by an air gap made from two thicknesses of ordinary writing paper. This change permits the high-impedance side to handle the 815 plate and screen currents without saturation. Of course, the inductance is reduced, and the extreme low-frequency response is chopped off, but this is a desirable characteristic for speech modulation. It helps to make voice reproduction crisper and more intelligible, and at the same time reduces the amount of ac hum on the carrier. See QST, January 1946, page 51, "Link Coupled Modulator."

For the initial tune-up, connect a 25-watt Mazda lamp across the antenna hairpin loop. Then, with the feedback (grid circuit) plates set about ¼ inch from the 815 envelope, rotate the capacitor to a point where the tube oscillates. Next, squeeze or spread the plate tank to get the oscillator on frequency, and reset the grid capacitor. Then, adjust the antenna hairpin loop to give maximum RF with minimum coupling.

With a plate voltage of 400 volts and a plate current of 150 ma, there should be enough RF output to light a 25 watt lamp to full brilliancy. Those who have been there know that it takes much less than 15 watts of RF at 144 Mc to bring in R9 reports.

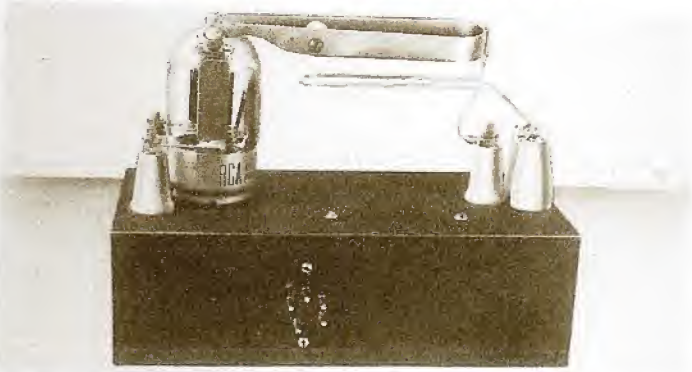
A 15-watt speech amplifier will put a great deal of audio on the carrier generated by this transmitter. The quality, as heard on a super-regenerative receiver, will be as good as the audio amplifier and modulator will permit.

Here is a hot little package that can be built at small cost, with a minimum of time and trouble—one that will "get you upstairs" and how!

PARTS LIST

L1 = Copper strap, ½" wide, 3" long, bent in shape of "U"
L2 = #14 wire, 3" long
L3 = Feed-through insulators.
L4 = Copper strap, ½" wide x 2" long, soldered to #12 wire, 2" long
L5 = Copper strap, ½" wide, 12" long, bent into hairpin, tapered to ¼" at each end.
L6 = RFC, #16 copper wire, 20" long, wound on ¼" mandrel.
L7 = Antenna hairpin, #12 wire, 10" long
R1 = 15,000 ohms, 2 watts, carbon
R2 = 10,000 ohms, 10 watts, wire wound
C1 = Mica capacitor, 500 $\mu\mu f$.
C2 = 5 plate variable capacitor
T1 = Universal output transformer, Thordarson T-13S42 or similar.
RCA-815 $6.25 at your distributor.

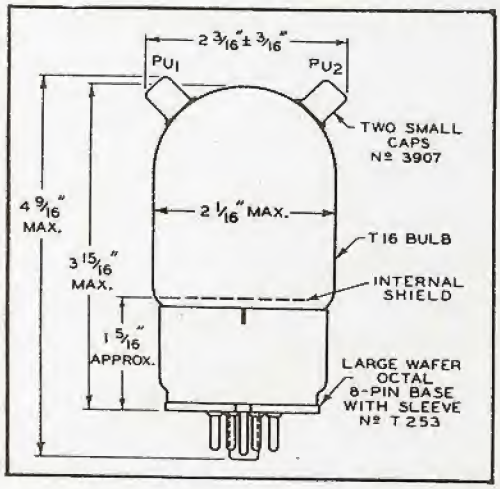
SIMPLE OSCILLATOR ALL SET TO GO



Top view of the transmitter. A little bit of copper and a few ceramic insulators put the 815 to work.

PUSH-PULL BEAM POWER AMPLIFIER

75 WATTS INPUT TO 2 METERS *Amateur Net* **$6.25**



RCA 815

Features

- THE ABILITY OF THE 815 TO TAKE FULL POWER INPUT AT LOW PLATE VOLTAGE PERMITS THE USE OF A LOW-COST POWER SUPPLY.
- CLOSE SPACING OF THE PLATES REDUCES RADIATION LOSSES, AND SYMMETRICAL ARRANGEMENT OF THE ACTIVE ELEMENTS MAKES THE 815 IDEAL FOR VHF SERVICE.
- DOUBLE-ENDED CONSTRUCTION, EXCELLENT INTERNAL SHIELDING, AND LOW RESIDUAL GRID-PLATE CAPACITANCE MAKE THE 815 EASY TO NEUTRALIZE.
- THE GLASS BUTTON STEM, LOW-LOSS MICANOL BASE, AND THE GROUNDED METAL SHELL MAKE AN EXCELLENT FOUNDATION FOR THE RCA-815.

Application

Frequency Multiplication With push-pull grids and push-pull plates, the 815 is an excellent tripler. With push-pull grids and parallel plates, the 815 is a high-efficiency doubler.

Plate Modulation The 815 makes an excellent modulated final amplifier, with the screen-grid fed from the modulated plate supply through a series resistor by-passed for RF only.

Intermittent Telegraphy The 815 may be keyed in its grid, screen, or plate circuits. Under key-up conditions, electrode potentials should never exceed minus 175 volts on the control grids, 225 volts on the screen grids, or 600 volts on the plates.

Neutralization The high power gain of the 815 requires that the grid circuit be shielded from the plate circuit. Complete neutralization can be performed by putting a copper tab near each plate and connecting each tab to the opposite grid terminal.

Driving Power Requirements At moderate frequencies, the driving stage should furnish one watt of useful power. At 150 Mc the driver should have about 3 watts output. A pair of 6C4's in push-pull is recommended.

CHARACTERISTICS and RATINGS

Unless otherwise specified, values are for both units

HEATER (A. C. OR D. C.):			
Voltage per Unit	6.3		Volts
Current per Unit	0.8		Ampere
TRANCONDUCTANCE, for plate current of 25 ma.	4000		Micromhos
GRID-SCREEN MU-FACTOR	6.5		
DIRECT INTERELECTRODE CAPACITANCES (EACH UNIT):			
Grid-Plate (With external shielding)	0.2	*max.*	μμf
Input	13.3		μμf
Output	8.5		μμf

MAXIMUM CCS and ICAS RATINGS with TYPICAL OPERATING CONDITIONS

As Plate-Modulated Push-Pull R-F Power Amplifier—Class C Telephony

Carrier conditions per tube for use with a max. modulation factor of 1.0

	CCS	ICAS	
D-C PLATE VOLTAGE	325 *max.*	400 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No. 2)	225 *max.*	225 *max.*	Volts
D-C GRID VOLTAGE (Grid No. 1)	—175 *max.*	—175 *max.*	Volts
D-C PLATE CURRENT	125 *max.*	150 *max.*	Ma.
D-C GRID CURRENT	7 *max.*	7 *max.*	Ma.
PLATE INPUT	40 *max.*	60 *max.*	Watts
SCREEN INPUT	4 *max.*	4 *max.*	Watts
PLATE DISSIPATION	13.5 *max.*	20 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	325	400	Volts
D-C Screen Voltage #			
From a fixed supply of	165	175	Volts
From a series resistor of	10000	15000	Ohms
D-C Grid Voltage of	—45	—45	Volts
From a grid resistor of **	11250	15000	Ohms
Peak R-F Grid-to-Grid Voltage	112	116	Volts
D-C Plate Current	123	150	Ma.
D-C Screen Current	16	15	Ma.
D-C Grid Current (Approx.)	4	3	Ma.
Power Output (Approx.)	30	45	Watts

As Push-Pull R-F Power Amplifier and Oscillator—Class C Telegraphy

Key-down conditions per tube without modulation

	CCS	ICAS	
D-C PLATE VOLTAGE	400 *max.*	500 *max.*	Volts
D-C SCREEN VOLTAGE (Grid No. 2)	225 *max.*	225 *max.*	Volts
D-C GRID VOLTAGE (Grid No. 1)	—175 *max.*	—175 *max.*	Volts
D-C PLATE CURRENT	150 *max.*	150 *max.*	Ma.
D-C GRID CURRENT	7 *max.*	7 *max.*	Ma.
PLATE INPUT	60 *max.*	75 *max.*	Watts
SCREEN INPUT	4.5 *max.*	4.5 *max.*	Watts
PLATE DISSIPATION	20 *max.*	25 *max.*	Watts
TYPICAL OPERATION:			
D-C Plate Voltage	400	500	Volts
D-C Screen Voltage			
From a fixed supply of	145	200	Volts
From a series resistor of	15000	17500	Ohms
D-C Grid Voltage			
From a fixed supply of	—45	—45	Volts
From a cathode resistor of	260	265	Ohms
From a grid resistor of **	10000	13000	Ohms
Peak R-F Grid-to-Grid Voltage	116	112	Volts
D-C Plate Current	150	150	Ma.
D-C Screen Current	17	17	Ma.
D-C Grid Current (Approx.)	4.5	3.5	Ma.
Power Output (Approx.)	44	56	Watts

Fixed supply, modulated simultaneously with the plate supply, is recommended. Series resistor connected to *modulated* plate-voltage supply may also be used.

** The grid-circuit resistance should never exceed 15000 ohms (total) per tube, or 30000 ohms per unit. If additional bias is necessary, a cathode resistor or a fixed supply should be used.

HAM TIPS is published by the RCA Tube Department Harrison, N. J., and is available to Amateurs and Radio Experimenters through RCA tube and parts distributors.

RCA

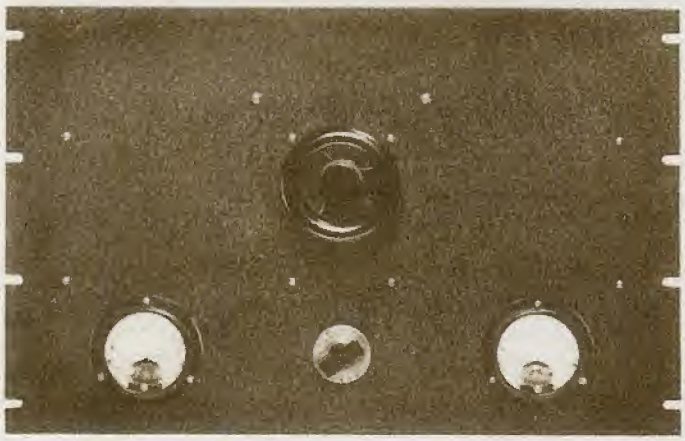
Ham Tips

PUBLISHED - IN - THE - INTEREST - OF - RADIO - AMATEURS - AND - EXPERIMENTERS

VOLUME VI, No. 2 EDITORIAL OFFICES, RCA, HARRISON, N. J. SEPTEMBER, 1946

FINAL AMPLIFIER USING PAIR OF RCA-813's IS A DX DEMON

"SUPER-SLUGGER" HIGH POWERED FINAL



Panel view of the unit which uses a pair of RCA-813's, has low drive requirements and automatic correction of L/C ratio for all bands.

COMPACT OSCILLATOR A GIANT PERFORMER FOR 2 METER WORK

By J. H. Owens
W3ASZ/2
Amateur Sales. RCA Tube Department

Try this one for size! And if you are one of those Hams who agree that good things comes in small packages, you will like the "Ninety-Ninety" oscillator.

The "Ninety-Ninety", or "90+90", if you prefer, is exceptionally small and compact. But the components are not overly crowded. In fact, as can be seen from the photographs, there is space enough for the modulation transformer in a cabinet only 3" x 4" x 5"—just in case you want to use plate-and-screen modulation.

Starting at the beginning, the 90+90 is a push-pull oscillator, having a tuned plate tank and a tuned grid tank. Intermediate between the two, and coupled to both of them is a third tank circuit, also tuned. That makes three tank circuits, all tuned to the same frequency, and all doing their utmost to hold the transmitter on frequency.

Ninety-Ninety, you see, is not just the name of the oscillator, it is also a significant expression for the principle of operation.

Electromagnetically speaking, two loosely-coupled tank circuits are 90 degrees apart in phase, and if a third one is loosely coupled to the second (and properly polarized), there will be a total phase shift of "90 plus 90" or 180 degrees.

The meaning of all this is that a tube will oscillate at the resonant frequency of its grid and plate tank circuits only when they are both tuned to the same frequency, and are exactly 180 degrees out of phase. Under any other condition, the frequency will have to deviate from resonance to provide the reactance necessary for this phase difference.

The surprising characteristic of the Ninety-Ninety is the way it "tracks" in tuning. When it is properly adjusted, the points of

(Continued on Page 3, Column 1)

NOVEL RIG COVERS 10-80 BAND FOR PHONE OR CW APPLICATION

By M. L. "Doc" Redman
W2PBX (Ex-W9ENK/2)
Manager, Electron Microscope Section, RCA Service Co., Inc.

Four months ago this station put a pair of RCA-813's in a new final amplifier, and shoved a full kilowatt into them. They took the soup without blushing, and the recent announcement of new tube ratings has proved our point. The new post-war RCA-813's are bigger and better than ever, and the reduced price of $14.50 makes them the logical choice for that high-powered final.

A casual inspection of the pictures will show no parasitic chokes, or other electrical or mechanical corrective gadgets. Instead, observation reveals symmetry, and complete band coverage from 10 to 80. The thing we like best of all is the feature that the plug-in coils can be changed from either side, top, or rear, whichever is most convenient.

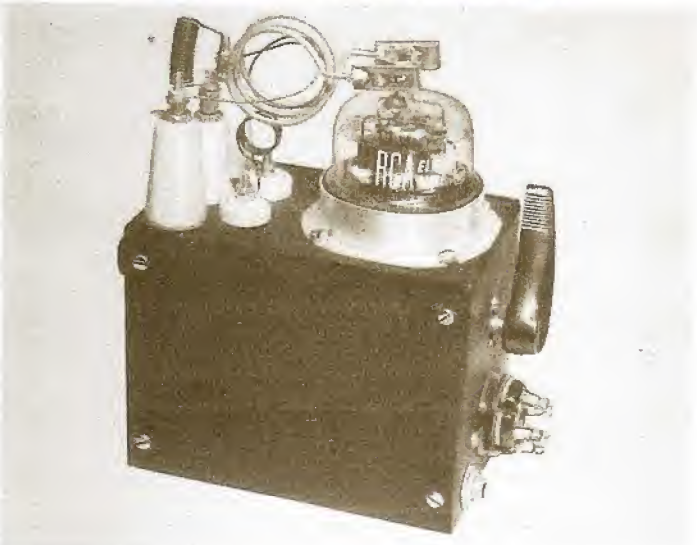
What more do you want in a unit of this kind? Quick band change without neutralization? Low drive requirements? Provisions for both phone and CW operation? Automatic correction of L/C ratio for all bands? No bugs, parasitics, or other forms of electronic vermin? Ease of construction with ordinary hand tools? You get all these and "heavenly reports too" with the 813 "Super Slugger".

As can be seen, the transmitter is built around a pair of National TMA-100-DA split-stator variable condensers, a Millen 10,000 worm gear drive unit, a set of B & W type TVH plate tank coils, a set of National AR-16 grid coils, and of course, a pair of those big beam "bottles".

The two variable condensers are mounted end-to-end into the worm

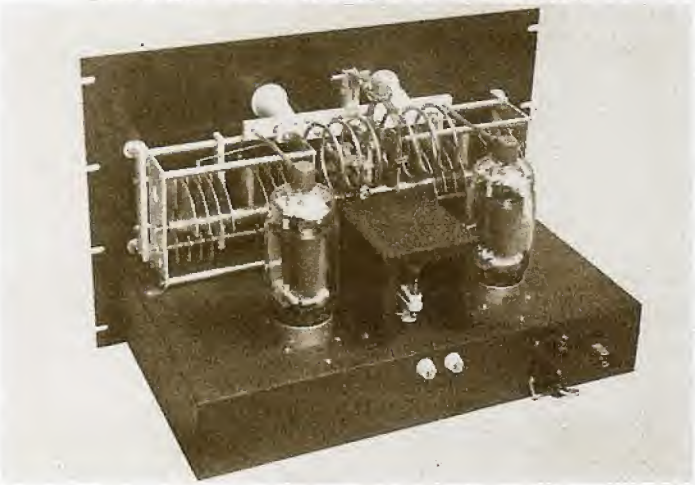
(Continued on Page 2, Column 1)

"NINETY-NINETY" RARIN' FOR THE AIR



This diminutive oscillator develops remarkable power output even though it is housed in a 3" x 4" x 5" cabinet.

DESIGNED FOR SYMMETRY AND EFFICIENCY



Rear view of "Super-Slugger" reveals clever removable shield which permits coils to be changed with maximum convenience.

NOVEL RIG

(Continued from Page 1, Column 4)

drive unit. In this arrangement, they serve as chassis mounting brackets as well as the source of capacitive reactance. The frame bases are bolted to the panel, and the frame sides are bolted to the chassis by means of ½" angle brackets. A very substantial mechanical linkage is the result.

All four sections of the condensers are used for 80 and 40, and only one section of each condenser for 20 and 10 meters. Adequate capacitance is supplied on all bands by this arrangement. Two turns were removed from the 80-meter coil, as well as from the 40, 20, and 10-meter coils. This was done to keep harmonics to a minimum, and to keep the signal extra sharp so as to prevent BCL interference. (We are apartment house dwellers.)

Circuits Isolated

The final tank-coil swinging-link assembly is suspended from the panel with two 1¾" insulators, which almost places the soldering lugs of the unit directly above the connecting points on the condensers. It is not possible to see the plate rf choke which is mounted on a feed-through insulator located between the panel and gear drive. This placement aids in further isolating the grid and plate circuits. The screen circuit is conventional with a possible exception that each tube is individually by-passed to ground and that the plate by-pass capacitor is connected to the screen circuit. This is done for best phone performance, as it serves to prevent loss of high-frequency audio response. It will be noticed by referring to the bottom view of the chassis that all by-pass capacitors from the screen and filament leads are connected directly to ground in the region of each socket through socket mounting bolts. One mica filament capacitor is located at each socket, by-passing one and the other side of the filaments. The beam-forming plates are placed at ground potential through connection to socket mounting bolts.

One method of supplying the screen voltage, consists of a voltage divider circuit which automatically prevents the screen voltage from rising to the plate potential if the space current is reduced to zero. Details for determining values for the voltage divider circuit will be found in an article "Fool Proof Screen Feed" by W. E. Roberts, Radio Corporation of America, Page 38, October 1940 QST.

The screen grids can also be fed from the plate supply through a series resistor, or they can be fed from a separate supply. If either of these methods is employed and the amplifier is used for CW work, precautions must be taken to prevent excessive screen dissipation or voltage during key-up conditions.

All grid components are completely isolated from the plate circuit. This is imperative to prevent self-oscillation of the tubes. The plug-in grid coil is housed in a removable shield above the chassis which plugs in like a coil assembly, facilitating quick coil changing.

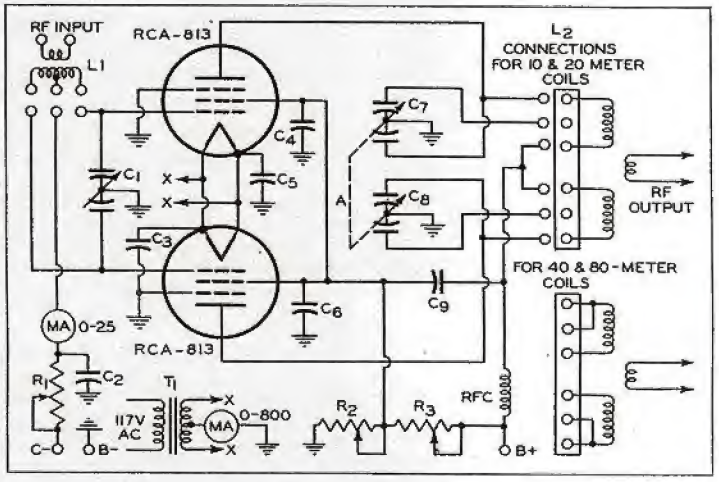
Short direct connections from the grid coil to the grid condenser and then to the grid proper is made possible by placing the grid condenser between the two sockets. It will be noted that the grid bias terminal at the back of the chassis is grounded externally. This is not an innovation but rather was done for convenience at this station. Fixed bias is placed in the grid circuit by removing the grounded plug and substituting one from the bias supply. Grid-leak bias has been used entirely for phone operation. However, it is good practice to combine fixed bias with grid-leak bias for purposes of tube protection, during periods of no excitation, whether caused by key-up periods or by failure of a preceding stage.

More than sufficient excitation was supplied to the amplifier from 80 through 10 meters from a conservatively operated 807 doubler. The needle of the 25 milliampere meter in the 813 grid circuit can be pushed to the pin with only 30 to 50 plate mils at 450 volts to the 807.

Meter Functions

The plate and grid meters are conventionally located in the circuit. The plate meter is in the cathode circuit, and therefore reads the total of screen, plate, and grid currents. All circuits, screen, grid, and plate, have been checked individually and this probably should be considered recommended procedure because too high screen current and voltage will result in excessive dissipation while too low screen voltage will reduce the output. If the grid-leak resistor is returned to the top side of the plate current meter instead of to ground the plate meter will not read grid current.

The unit is entirely free of parasitics and remains stable during periods of 100% modulation. Many compliments have been received commenting on the sharp powerful signal and fine 'phone quality. Probably the nicest one comes from W2PLF who admired the amplifier's efficiency and performance to the point of constructing an identical unit.



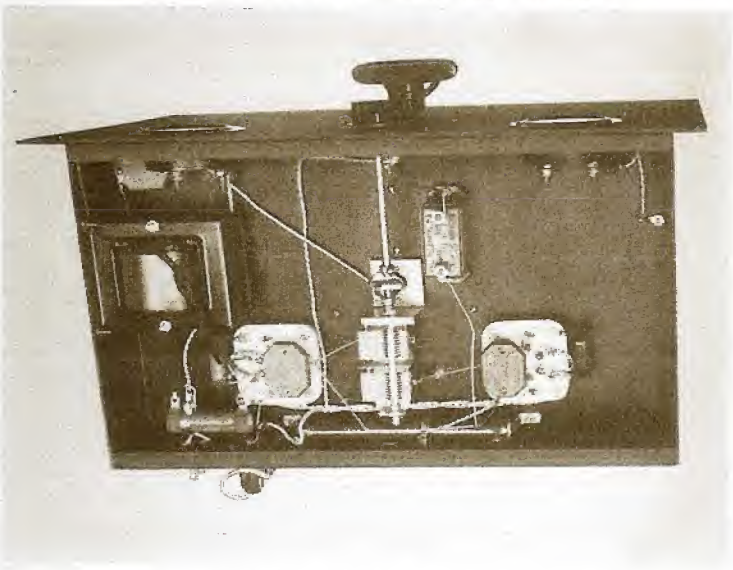
"Super-Slugger" Schematic

PARTS LIST

L1 National AR-16 center-link coils.
L2 B & W type TVH (see text).
A Millen 10,000 worm drive gear.
C1 100 μμf per section, split-stator, variable.
C2 0.006 μf, 500 volt, mica.
C3, C5 0.002 μf, 500 volt, mica.
C4, C6 0.003 μf, 2500 volt, mica.
C7, C8 50 μμf per section, split-stator, variable, 0.171" spacing.
C9 0.002 μf, 5000 volt, mica.
R1 25,000 ohm, adjustable, 25 watt, WW.
R2 25,000 ohm, adjustable, 25 watt, WW.
R3 50,000 ohm, adjustable, 75 watt, WW.
T1 10 volt, 10 ampere, filament transformer.
RFC National R-175 or R-154U.

SEE P 3 HAM-1947

SIMPLE MECHANICAL WORK AND WIRING



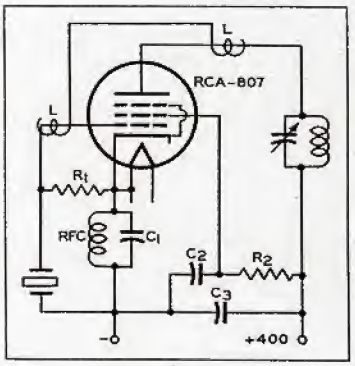
Bottom view of the final amplifier shows how all grid components are completely isolated from plate circuit to prevent self-oscillation of tubes.

807 XTAL. OSCILLATOR CONVERTS THIS RIG FROM 40 TO 15 METERS

By J. L. REINARTZ
Power Tube Group, RCA Lancaster Engineering Section

I was asked the other day what I would do to my transmitter to be able to operate in the 15-meter band. My solution would be to use a suitable 40-meter crystal, which I have, and triple to the 15-meter band in the plate circuit of an 807 crystal oscillator.

A laboratory set-up proved the point. The 807 crystal oscillator operated well at the fundamental, the second and the third harmonic, and proved capable of driving an 813 at 21 Mc. The following circuit arrangement was used and can readily be duplicated.



PARTS LIST

C1 100 $\mu\mu$f midget, mica.
C2 0.005 μf midget, mica.
C3 0.005 μf midget, mica.
L, L Piece of insulated wire looped one or two turns around plate and grid leads.
R1 25,000 to 50,000 ohms, 2 watt carbon.
R2 25,000 ohms, 5 watt WW (50,000 ohms if plate supply exceeds 500 volts).
RFC Single layer coil, #24 enameled wire, coil 1½ inches long, ⅜ inch diameter.

COMPACT OSCILLATOR

(Continued from Page 1, Column 2)

minimum plate current, maximum grid current, and maximum rf output will all fall at the same points of tuning. This is a good indication that the grid and plate tanks are separated by two 90-degree phase shifts.

The plate tank is on top of the chassis, and is supported by the Fahnstock plate clips and the rf feed choke. It is tuned by the expedient of squeezing or spreading the turns.

Loose Coupling

Mounted on two feed-through insulators, and very loosely coupled to the plate tank, is the pick-up coil that feeds the intermediate coupling tank. This tank is tuned by a variable condenser, and is in turn very loosely coupled to the grid tank, which is also condenser tuned. The desired result is accomplished. (A lot of tanks, eh, what?)

The accompanying photographs, the circuit diagram, and the parts legend, illustrate the oscillator well enough to make it easily duplicated. That leaves little else to put in writing except some pointers derived from experience in the building of three models.

The first point to be kept in mind is that the three tanks must be loosely coupled. If they are closely coupled, the tuning will be broad, and the setting for maximum grid current and rf output will not track with the plate current dip.

The second point for attention is the adjustment for optimum grid drive. The tendency may be toward too little grid drive with loose coupling. If this happens, it can be corrected by using more inductance and less capacitance in the grid tank. The use of more wire in the intermediate tank pickup coil also helps to provide more drive with a given degree of coupling to the plate tank. Use of the smallest amount of grid current that will provide upward modulation is recommended.

Final Adjustment

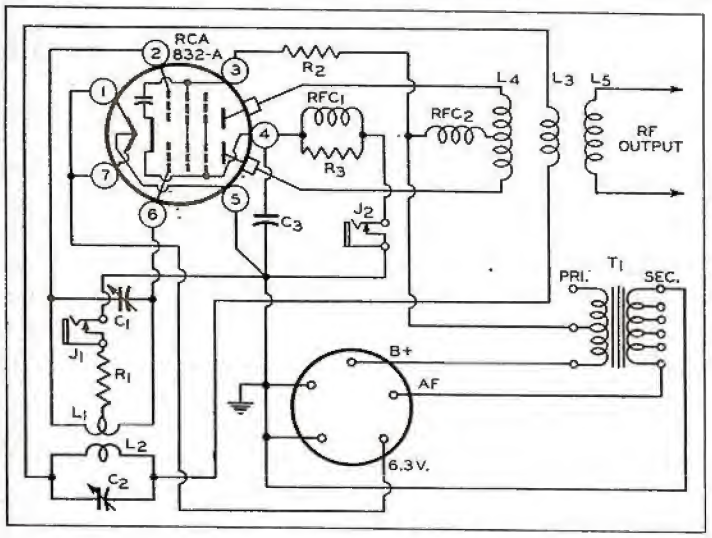
The third and last point, is to make sure that the intermediate tank pickup loop is properly polarized. If it is wound in the wrong direction, the oscillator will not function when all circuits are tuned to resonance. Instead, oscillations will occur when the intermediate tank is tuned to either side of resonance! Reversing the winding will correct this in a jiffy.

Either the 832-A or the 829-B will give good performance at 1¼ as well as 2 meters. The 829-B has higher input and output capacitance, therefore will require less inductance and capacitance in the tank circuits. The 815 performs nicely at 2 meters, but should not be expected to work the higher frequency band. A pair of 2E26's can also be used with good results. As illustrated, the oscillator will work only the 2-meter band.

The initial tune-up should be done with reduced power on the tube. A milliammeter should be connected in series with the plate and screen voltage supply. Also, a milliammeter should be connected in series with the grid-bias resistor, or a voltmeter should be connected across it. A 15-watt incandescent lamp should next be connected across the antenna pickup loop.

The grid tank condenser and the intermediate tank condenser should be tuned for maximum rf output. Then the plate tank coil should be squeezed or spread to get the oscillator on frequency, and the variable condensers should be tuned again. Preliminary adjustments should be made for lowest plate current.

In the final adjustment, the point of minimum plate current will track with the point of maximum grid current to develop the greatest power output, and then the Ninety-Ninety will prove deserving of its name.

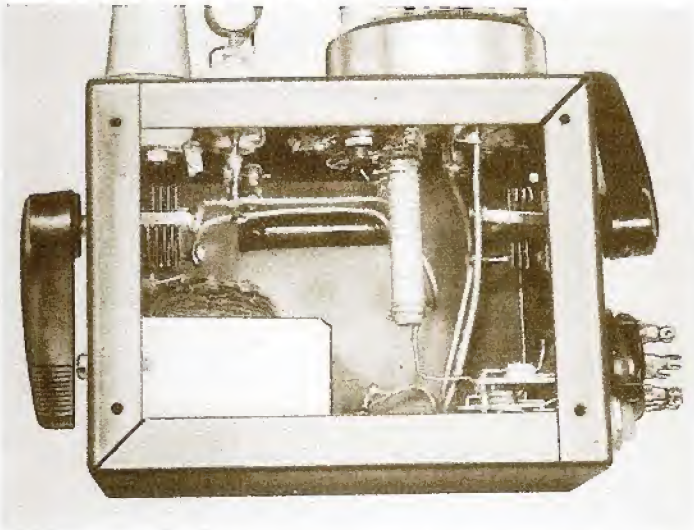


Compact Oscillator Schematic

PARTS LIST

L1 Grid tank, 7 inches #12 wire in hairpin loop.
L2 Intermediate coupling tank, 7 inches #12 wire in hairpin loop.
L3 Pickup coil, 4 turns #18 wire, ½ inch diameter coil.
L4 Plate tank, 3 turns #10 wire, 1½ inches diameter coil.
L5 Antenna coil, 1 inch diameter, 2 turns #18 wire.
C1 6 plate midget variable, ceramic frame.
C2 9 plate midget variable, ceramic frame.
C3 500 $\mu\mu$f midget mica, 500 volt.
R1 30,000 ohm, 5 watt, WW (2 watt carbon Okay).
R2 15,000 ohm, 5 watt, WW.
R3 100,000 ohm, 2 watt, carbon.
RFC1 38 inches #26 DSC wound on R3.
RFC2 20 inches #18 enameled wire wound on ¼ inch mandrel, coil 1 inch long.
J1 & J2 Closed circuit phone jack.
T1 Universal output transformer, 10 watt size, with air-gap in core.

SMALL, COMPACT, BUT NOT CROWDED



Well planned placing of components in the 3" x 4" x 5" cabinet leaves sufficient space to work with soldering iron and tools.

RCA-813 TRANSMITTING BEAM POWER AMPLIFIER

500 WATTS INPUT TO 30 MEGACYCLES

Amateur Net **$14.50**

RCA 813

Features

- *No Neutralization.* QUICK BAND CHANGE FROM "EIGHTY" TO "TEN".
- *High Power Gain.* ABOUT 4½ WATTS OF DRIVING POWER IS REQUIRED.
- *Real Ham Value.* THIRTY-FOUR-PLUS WATTS-PER-DOLLAR.
- *High Efficiency.* FULL PLATE-CIRCUIT EFFICIENCY AS HIGH AS 30 MC.
- *Low Screen Current.* MORE EFFICIENT USE OF DC AND AF POWER.

Behind the superb performance features of the RCA-813 are the following important electrical and mechanical design features:

1. Element supporting dome-top bulb.
2. Low-resistance, dual-ribbon plate leads.
3. Pure, gas-free, alumina insulators.
4. Electron-confining capacitance shield.
5. 50-watt thoriated-tungsten filament.
6. 125-watt non-warping graphite anode.
7. Nonex hard-glass straight-side bulb.
8. Unobstructed guarded getter.
9. Low-loss glass-dish stem.
10. Drawn tungsten metal-to-glass seals.
11. Short-leads for low internal inductance.

Application

Driving Power. A small crystal oscillator will provide adequate drive at frequencies of 3 to 7 Mc. At 30 Mc., an 807 doubler will drive a pair of 813's, with power to spare.

Shielding. The high power gain of the 813 necessitates complete shielding of the grid circuit from the plate circuit. Neutralization is not required.

Plate Modulation. The screen grid must be modulated simultaneously with the plate. The screen grid voltage can be taken from a fixed supply, fed through a modulation transformer winding. A less efficient but equally satisfactory method is to feed the screen grid through a dropping resistor connected to the modulated plate supply.

Class C Telegraphy. Under key-up conditions, the screen grid potential should not exceed 800 volts. If a preceding stage is keyed, a fixed bias of about 45 volts should be used to limit the plate current to a safe value.

Frequency Multiplication. Use Class C telegraphy ratings, but increase grid bias and grid current to point that produces optimum efficiency. Proper values will be approximately twice those given.

RF Bypassing. In plate-modulated telephony service, where the screen grid is fed through a series resistor from the modulated plate supply, the plate-circuit should be by-passed to the screen grid, and the screen grid should be by-passed to cathode. The screen by-pass capacitor should be about three times as large in value as the plate capacitor.

NEW RATINGS — RCA-813

Plate-Modulated R-F Power Amplifier—Class C Telephony

Maximum Ratings, Absolute Values

	CCS	ICAS
D-C Plate Voltage	1600 max.	2000 max. volts
D-C Screen Voltage (Grid No. 2)	400 max.	400 max. volts
D-C Grid Voltage (Grid No. 1)	—300 max.	—300 max. volts
D-C Plate Current	150 max.	200 max. ma.
D-C Grid Current	25 max.	30 max. ma.
Plate Input	240 max.	400 max. watts
Screen Input	15 max.	20 max. watts
Plate Dissipation	67 max.	100 max. watts

Typical Operation

D-C Plate Voltage	1250	1600	2000 volts
D-C Screen Voltage*	400	400	350 volts
From a series screen resistor of	53,000	60,000	41,250 ohms
D-C Grid voltage**	—120	—130	—175 volts
From a grid resistor of	30,000	21,600	41,000 ohms
Peak R-F Grid Voltage	195	210	300 volts
D-C Suppressor Voltage (Grid No. 3)	0	0	0 volts
D-C Plate Current	150	150	200 ma.
D-C Screen Current	16	20	40 ma.
D-C Grid Current (Approx.)	4	6	10 ma.
Driving Power (Approx.)	0.7	1.2	4.3 watts
Power Output (Approx.)	135	175	300 watts

*Obtained preferably from a fixed supply modulated simultaneously with plate voltage, or from modulated plate supply through series resistor of value shown.

**Obtained from a grid resistor of value shown or from a combination of grid resistor with either fixed supply or cathode resistor. Total effective grid circuit resistance should not exceed 30,000 ohms.

R-F Power Amplifier and Oscillator—Class C Telegraphy

Maximum Ratings, Absolute Values

	CCS	ICAS
D-C Plate Voltage	2000 max.	2250 max. volts
D-C Screen Voltage (Grid No. 2)	400 max.	400 max. volts
D-C Grid Voltage (Grid No. 1)	—300 max.	—300 max. volts
D-C Plate Current	180 max.	225 max. ma.
D-C Grid Current	25 max.	30 max. ma.
Plate Input	360 max.	500 max. watts
Screen Input	22 max.	22 max. watts
Plate Dissipation	100 max.	125 max. watts

Typical Operation

D-C Plate Voltage	1250	1500	2000	2250 volts
D-C Screen Voltage†	300	300	400	400 volts
From a series resistor of	27,000	40,000	36,000	46,000 ohms
D-C Grid Voltage‡				
From a fixed supply of	—75	—90	—120	—155 volts
From a grid resistor of	6000	7500	12,000	10,000 ohms
From a cathode resistor of	330	400	520	565 ohms
Peak R-F Grid Voltage	160	175	205	275 volts
D-C Suppressor Voltage (Grid No. 3)	0	0	0	0 volts
D-C Plate Current	180	180	180	220 ma.
D-C Screen Current	35	30	45	40 ma.
D-C Grid Current (Approx.)	12	12	10	15 ma.
Driving Power (Approx.)	1.7	1.9	1.9	4 watts
Power Output (Approx.)	170	210	275	375 watts

†Obtained from a separate source, from the plate-voltage supply with a voltage divider, or through a series resistor of value shown. Series screen resistor should be used only where the 813 is employed as a buffer amplifier and is not keyed. The screen voltage must not exceed 800 volts under key-up conditions.

‡If preceding stage is keyed, partial fixed bias is required.

SEE PAG 3 NOV-DEC 1946

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H. S. STAMM ..... *Editor*
J. H. OWENS ..... *Technical Editor*

RCA Ham Tips

PUBLISHED - IN - THE - INTEREST - OF - RADIO - AMATEURS - AND - EXPERIMENTERS

VOLUME VI, No. 3 EDITORIAL OFFICES, RCA, HARRISON, N. J. NOV.—DEC. 1946

NEW "HAM" RATINGS ANNOUNCED FOR RCA RECEIVING TUBES

GRID CONTROLLED POWER SUPPLY IS A VERSATILE UNIT

Uses Pair of RCA-2050's for Wide Voltage Range

By J. H. Owens, W2FTW
and G. D. Hanchett, W1AK/2

A power supply that will deliver up to 200 Ma at any voltage from about 50 to 400 volts! Does this appeal to you? If it does, and if you want this convenience at low cost without the losses of tapped bleeder resistors or expensive variable transformers, but with good voltage regulation, just by setting a small potentiometer—here's how!

It's done with grid-controlled rectifiers, commonly known as thyratrons. And what are they? They are simply rectifiers containing gas to reduce the voltage drop and to improve the efficiency, and having one or more grids interposed between the plates and cathodes to control the start of plate current flow.

In the power supply to be described, a pair of RCA-2050's are used to deliver the current at the desired voltage. Within its capabilities a unit like this permits the convenient reduction of power during tune-up of that new rig, and a moment later, its operation at full input. For experimental work, such a unit is an invaluable laboratory tool.

Theory of Operation

Refer to Figure 1 which illustrates the critical control characteristics of a thyratron tube. The heavy solid line represents the ac voltage impressed on the plate of one of the rectifiers in a full-wave circuit; and the dashed line represents the critical instantaneous grid voltage that must simultaneously be put on the control grid of this tube to prevent it from ionizing or "firing". In this condition, neither tube will pass plate current, and the output of the rectifier will be zero.

The dotted line represents an in-phase voltage which, if impressed upon the grid of the thyratron, will cause it to fire at the start of the cycle and conduct throughout its duration, at which time the plate

(Continued on Page 3, Column 1)

REAL "HAM" VALUE

Here's another instance which proves "Hams" get the most for their money when they use RCA tubes. In a series of studies recently concluded by the Tube Department and covering the sale of 100,000,000 receiving tubes on which field records were obtained, less than 1½% were involved in defective claims. Only 1% were found to be actually defective. A major factor in this remarkable record has been the accumulation and carryover of RCA "know-how" to answer the requirements of modern electronic equipment.

DATA GUIDES RECEIVING TYPE USE IN LOW POWER TRANSMITTER STAGES

For you Hams who use receiving tubes for low power transmitting applications—and was there ever a Ham who did not—here are regular rf class C ratings for nine popular RCA receiving types. These tubes are favored for oscillators, buffers, frequency multipliers, and low-power final amplifiers because they supplement the regular line of small transmitting tubes. Therefore, most of them have become standard equipment in Ham Shacks. Their limitations, however, have frequently been a matter of conjecture. With the new ratings now established, all Amateurs have a reliable guide for obtaining the most hours of useful life from RCA receiving tubes in transmitting applications.

For Hams Only

When we said the new ratings were established for you, the Amateurs, we meant *only* and *solely* and *strictly* for you, and for no one else. However, because Amateur rf use of these tubes represents something less than one per cent of the main use of the tubes, their characteristics cannot be determined solely by the requirements of this particular class of service.

In the course of time, receiving tubes may be modified to give major users more performance for less money. Progressive work of this nature has resulted in benefits well known to those who use the tubes. Unfortunately, such progress may result in changes in tubes which, although representing real improvement in their normal receiver function, may require redesign of transmitter equipment in which the tubes are used.

Hams welcome improvements and price reductions in tubes, and are quick to modify their gear to adjust for or take advantage of any changes which may be made. Manufacturers, on the other hand, rightfully expect and demand that no changes be made in tubes which will adversely affect their performance in commercial or production equipment. Therefore, manufacturers should not use these tubes according to the Ham ratings.

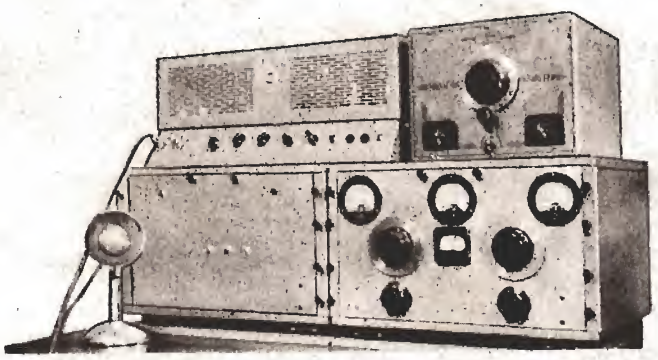
It should be recognized that Ham ratings are subject to change at a moment's notice and some of them may even be withdrawn.

Proceed With Caution

A quick examination of the accompanying table shows that the tubes have been given higher input ratings than heretofore. No longer do you have to learn the hard way what the margin of safety is for receiving tubes in transmitting practice, that is, by blowing up tubes. The tubes will take just as much, but no more, power input than be-

(Continued on Page 2, Column 1)

THIS MONTH'S PRIZE WINNER



James E. Hausser, W8LB, Cleveland, Ohio, takes top honors this month for this photo of his RCA tube equipped rig. Jim writes in to say he has worked Maine to California on 10-meter phone with R9 plus reports.

The lower right unit is the rf section; a Meissner Signal Shifter feeds an 807 which works into push-pull 807's. The unit at lower left houses the power supply, the modulation transformer, and the complete bias supply for the transmitter. Modulator is an RCA 50-watt amplifier, and the microphone, an RCA-MI-6206. Nice going, Jim, for a swell looking rig. Your $10.00 check is in the mail.

And to the rest of you tinkering, ingenious "Hams", let's have some photos of those rigs you've gotten together. Remember—if it's RCA tube equipped, you stand a bang-up chance to walk off with the month's prize money.

RECEIVING TUBE CLASS C TELEGRAPHY RATINGS ✻ EXCLUSIVELY FOR THE HAM

RCA Tubes (Type)	Maximum Plate Supply (Volts) Ebb	Maximum Screen Grid (Volts) E_{c_2}	Maximum Control Grid (Volts) E_{c_1}	Maximum Plate (Milliamperes) Ib	Maximum Screen Grid (Milliamperes) I_{c_2}	Maximum Control Grid (Milliamperes) (Note 2) I_{c_1}	Maximum Plate Dissipation (Watts) Pp	Maximum Screen Grid Dissipation (Watts) P_{c_2}	Power Output (Watts) (Note 1) Po	Maximum Frequency (Megacycles)* Mc	Grid Bias Calculator Mu Factor (Approximate)† μ	Grid to Plate Capacitance (uuf) Cgp	Input Capacitance (uuf) Cin	Output Capacitance (uuf) Cout
6AG7	375	250	− 75	30	9	5.0	9.0	1.5	7.5	10	22	max. 0.06	13	7.5
6AK6	375	250	−100	15	4	3.0	3.5	1.0	4.0	54	9.5	0.12	3.6	4.2
6AQ5	350	250	−100	47	7	5.0	8.0	2.0	11.0	54	10	0.35	7.6	6.0
6C4	350	—	−100	25	—	8.0	5.0	—	5.5	54	18	1.6	1.8	1.3
6F6	400	275	−100	50	11	5.0	12.5	3.0	14	10	7	0.2	6.5	13
6L6	400	300	−125	100	12	5.0	21	3.5	28	10	8	0.4	10	12
6N7	350	—	−100	30 (per plate)	—	5.0 (per grid)	5.5 (per plate)	—	14.5 (total)	10	35	—	—	—
6V6GT	350	250	−100	47	7	5.0	8.0	2.0	11.0	10	9	0.7	9.5	7.5
12AU7	350	—	−100	12 (per plate)	—	3.5 (per grid)	2.75 (per plate)	—	6.0 (total)	54	18	1.5	1.6	0.5 (approx.)

Notes (1) Power output based upon plate circuit efficiency of 70%.
(2) 100,000 ohms maximum grid resistor.
* Maximum frequency for full power output and input.
† For pentodes this is the grid-screen amplification factor.
✻ Maximum ratings are absolute maximum values not to be exceeded under any conditions of operation.

NEW "HAM" RATINGS

(Continued from Page 1, Column 4)

fore, the difference is that now you have exact information on which to base your operating practice.

In return for this confidence, it is expected that you will accept the ratings in good faith and not attempt to "stretch" them further. Reduced power should be used during tune-up, and other precautions taken to keep the tubes within the ratings.

Screen Grid Tubes Critical

Many of you Hams have found that triodes will stand more abuse than pentodes. The reason is that with pentodes and beam tubes it is comparatively easy to overload the screen. In triodes, the important limiting factor usually is only plate dissipation. Thus, in screen grid tubes we have two important limiting conditions, screen dissipation and plate dissipation. The need to watch both dissipation limits in the case of screen grid tubes is the price that has to be paid for the additional advantages gained. Good design practice indicates that the screen grid voltage should be adjusted at about 80% of the maximum value shown in the table.

When screen grid tubes are used as class C amplifiers, the screen current goes up directly with an increase in applied grid drive. This means increased screen dissipation. Therefore, grid driving power should be kept as low as possible, consistent with good power conversion efficiency.

General Application Notes

Specific conditions were not set up for the tubes as plate-modulated or plate-and-screen modulated amplifiers, because this use is a minor one. When such service is contemplated, the plate voltage should be reduced 20%, the screen grid (if present) voltage maintained, and the grid drive adjusted as recommended for doubler service. These modifications will protect the tubes and take into account the additional grid drive that is necessary.

When tubes are used as doublers or triplers, their efficiency is less than when they are used as straight-through amplifiers. For example, the plate circuit efficiency of a class C amplifier can easily be 70%, but the efficiency of a multiplier will ordinarily be something near the reciprocal of the order of the harmonic; viz., 50% (=½) for a doubler, and 33 1/3% (=1/3) for a tripler.

The significance of this is that because the efficiency is less, less power gets transferred to the load, hence more is dissipated in the tube. Therefore, as the plate efficiency goes down, the power input must also go down, otherwise the plate and screen dissipation ratings may be exceeded.

Tubes used as oscillators should be handled quite like class C amplifiers. The big difference between the two is that in oscillator service, the tubes must supply their own driving power. The power output will be equal to the plate power input, minus grid-driving power, copper losses, dielectric losses, radiation losses, harmonic losses, and the power dissipated in the plate and other tube electrodes. Efficiencies vary more widely in oscillators than in amplifiers, and on an average range from 25 to 60%.

Frequency Limits

The tubes may be operated at frequencies higher than those given in the table, but of course the power output will go down accordingly. As the power goes down, the plate (and screen) dissipation goes up; therefore, the power input must be reduced to prevent dissipation ratings from being exceeded.

As an indication of service ability, the octal types in the table perform usefully in the six-meter band, while the miniatures give a fair account of themselves in the two-meter band. To be on the safe side at these higher frequencies, reduce all ratings about 20% from the values shown in the table.

Neutralization

With the possible exception of 3 types, all of the tubes in the group positively require neutralization when used as 1 to 1 amplifiers. It may be possible to use the 6AG7, 6AK6, and 6F6 (metal) without neutralization because the average tube has relatively low grid-plate capacitance. This characteristic is usually not strictly controlled in production because it has no importance in audio output applications. Neutralize all the tubes and be sure.

Amplifier and Oscillator Conditions

Now we get down to the pleasurable business of putting the tubes to work, and the question is, "How do we use the new ratings?" They are all maximum permissible values, while the Amateur demand is for "typical operating conditions".

For oscillator and amplifier service, divide the plate voltage by the Mu factor. For a beam tube or pentode, divide the screen grid voltage by the Mu factor. This gives you the approximate bias for plate current cutoff. Double this and you have the correct value for class C operation. For the 6C4 with 350 plate volts grid bias will be approximately 40 volts.

The value of grid current is an arbitrary one. We have selected 80% of the maximum rated value as a satisfactory figure. That gives 6.5 Ma for the 6C4. The grid-leak bias resistor can be selected by dividing the grid bias by the grid current. Thus $40 \div 0.0065 = 6{,}000$ ohms (approx.) which is the proper value for the 6C4. It should be noted that 100,000 ohms is the maximum amount of resistance that should be used in the grid circuit of any of the tubes in the table.

Typical Multiplier Conditions

For doubler service, divide the plate voltage by the Mu factor, and multiply by three. Calculate the value of grid-leak bias resistance in the same manner as in amplifier and oscillator conditions. Normal grid current will be the same.

The foregoing grid-bias formulas anticipate normal power output and plate circuit efficiency consistent with minimum grid drive and the least amount of unwanted harmonics. Higher bias will make possible somewhat more output at the expense of increased grid-drive requirements. Optimum conditions for frequency multiplier service may demand bias values near the maximums shown in the table.

A FEW OF THE TUBES HAVING NEW HAM RATINGS

Amateurs now have a reliable guide for obtaining the most hours of useful life from these tubes in transmitting applications.

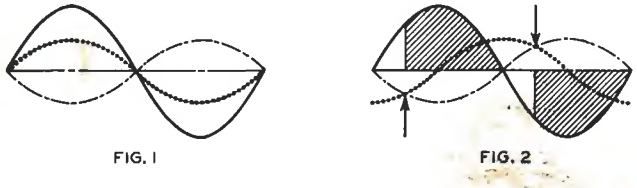


FIG. 1

FIG. 2

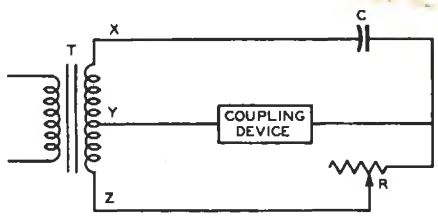


FIG. 3

Control characteristics of thyratron tubes and a basic phase controlling network.

POWER SUPPLY

(Continued from Page 1, Column 1)

voltage drops to zero and the tube deionizes, thereby restoring grid control. In this condition, both of the tubes act like regular diode rectifiers and deliver maximum power to the load.

Figure 2 shows the relationship of plate voltage versus critical-grid-voltage when a voltage of 90° displacement is impressed on the grid. The arrows indicate the instant where the actual negative grid voltage becomes more positive than the critical voltage for the applied plate voltage. At this point, ionization occurs, and current flows during the remaining part of the cycle as indicated by the shaded area. The dc output voltage delivered by the filter will be about three-quarters of the maximum obtainable. From this, it can be seen that variations in phase between applied anode voltage and grid voltage will produce more or less rectifier output. Carried to extremes, this means either full-voltage at full conduction or zero-voltage at zero conduction.

Phasing Circuit

Figure 3 shows the basic phase-controlling network. A transformer (T) has a center-tapped secondary winding connected to the coupling device. If the center-tap (Y) is used as a zero point, the voltage on one side (X) is, of course, 180° out of phase with the voltage on the other side (Z). Then, if the resistance (R) is high compared with the reactance of the capacitor (C), the coupling device is effectively connected across the upper half of the secondary (XY), and the voltage across it is in equal phase. But if the resistance (R) is low compared with the reactance of the capacitor (C), the coupling device is effectively connected across the lower half of the transformer secondary (YZ), and the voltage across it is now of reversed phase. In this position, the capacitor (C) is connected across the entire winding (XZ), but its reactance is high compared with the reactance of the transformer secondary, and no ill effects are produced. Intermediate values of resistance (R) will cause intermediate phase differences across the coupling device, and will provide the control that is so desirable.

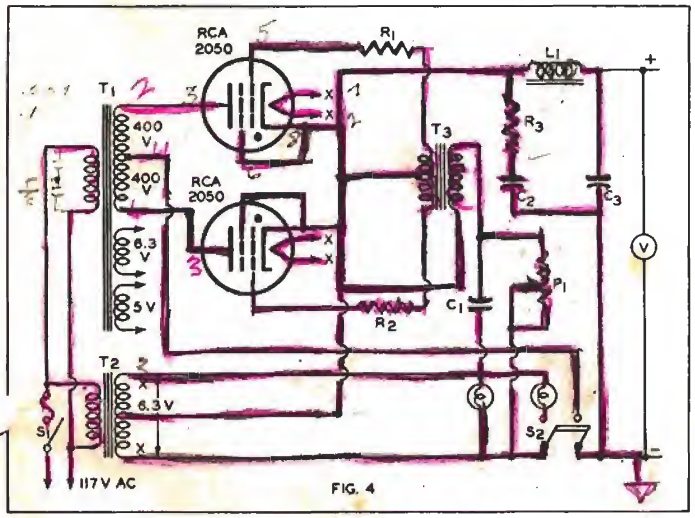


FIG. 4

Power supply schematic.

Construction Details

Figure 4 shows the complete circuit of the unit illustrated in the photograph. A separate filament transformer is used to heat the filaments of the RCA-2050's, light the pilot lamps, and supply the phasing voltage. A low-cost, unmounted transformer is used, and is located underneath the chassis. The 6.3- and 5-volt windings on the power transformer are left free and available for heating the filaments of a wide variety of tubes operated from the power supply.

Since a capacitance-input filter is employed, a resistor is used in series with the input capacitor to limit the peak current to the maximum rating. The value of this series resistor is approximately equal to 0.9 ohm per RMS volt of ½ the total secondary voltage of the supply transformer. For an 800-volt center-tapped secondary, the value of the resistor is approximately 800/2 x 0.9, or about 360 ohms.

The 100,000-ohm grid resistors are used to prevent excessive 2050 grid current and consequent loading of the phasing transformer. It may be necessary to reverse the transformer grid connections to get proper phase relation so that firing is prevented when the potentiometer is in a maximum-resistance position.

Don't worry about the 10-uf electrolytic capacitor being used in an ac circuit. Its reactance, or capacitance is practically the same in both directions, and the peak voltage of less than 10 is not high enough to cause it to be damaged.

The phasing transformer is a small-size audio unit, single plate to push-pull grids. It is mounted underneath the chassis in a convenient position.

Two switches are used to cut the unit on and off. S1 puts voltage on all tube heaters, and S2 delivers high voltage to the rectifiers. S2 should never be closed until the 2050 heaters have had a warm-up of at least 10 seconds, and preferably 30 seconds.

Operating Precautions

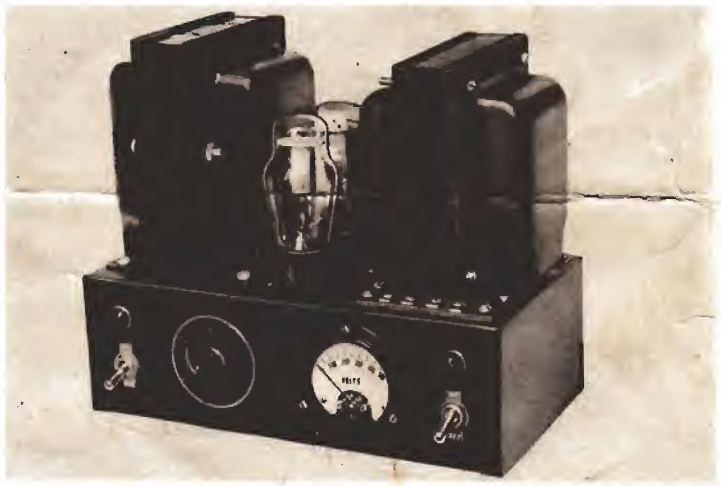
Because a capacitance-input filter is used, the voltage regulation will compare favorably with regular high-vacuum rectifiers. Therefore, the output voltage will rise considerably if the load is removed. The use of a swinging choke at the input to the filter will provide equivalent voltage regulation to standard circuits, but it will also limit the dc output voltage to approximately 90% of the RMS voltage of one-half the high-voltage transformer winding.

The photograph illustrates one satisfactory mechanical arrangement. The electrolytic filter capacitor is mounted directly in back of the 2050 rectifier tubes.

Benefits

All we can say here is that once you have built and used one of these grid-controlled thyratron power supplies, you will wonder how you ever managed to do without it in the past.

THE VERSATILE UNIT READY FOR WORK



It delivers up to 200 Ma at any voltage from 50 to 450 volts.

PARTS LIST

T1	Power transformer, 800 V., center-tapped secondary, 200 Ma capacity
T2	Filament transformer, 6.3 V., 1.2 amps
T3	Interstage audio transformer, single-plate to P-P grids
C1	10 μf, 150 V., electrolytic
C2 C3	8 μf each, dual electrolytic, 450 V. working
R1, R2	100,000 ohms, ½ watt, carbon
R3	360 ohms (approx.), 25 watt, wire-wound (see text)
P1	10,000 ohm wire-wound potentiometer
L1	Choke, 10 henries (approx.), 200 Ma.

ECHOS

In the September issue of Ham Tips, as well as in the letter-size data sheets which we distributed concerning the new ICAS ratings on the 813, we used poor arithmetic.

In the table under class C Telephony, ICAS, with 2000 volts on the plate, a grid resistor value of 41,250 ohms is shown. The correct value is 11,000 ohms for a grid current of 16 milliamperes.

RCA-2050 THYRATRON

HOT-CATHODE GAS-TETRODE *Amateur Net* **$1.70**

RCA 2050

Features

- *Excellent Efficiency.* SMALL TUBE DROP PERMITS GOOD RECTIFIER VOLTAGE REGULATION.
- *High Sensitivity.* AVERAGE PLATE-GRID CONTROL RATIO IS 250 TO 1.
- *Infinitesimal Grid Drive.* LESS THAN 0.1 MICROAMPERE CURRENT REQUIRED FOR FIRING.
- *Inert-Gas Filled.* EFFECTS OF AMBIENT TEMPERATURE CHANGES ARE NEGLIGIBLE.
- *Optional Mounting Position.* USE OF A HEATER-CATHODE DESIGN TOGETHER WITH AN INERT GAS ALLOW THE TUBE TO BE MOUNTED IN ANY POSITION.
- *Tetrode Construction.* ADJUSTMENT OF SHIELD-GRID VOLTAGE PERMITS CONTROL GRID TO HAVE EITHER NEGATIVE OR POSITIVE CONTROL CHARACTERISTICS.

Application

Rectifier Service. **Choke-input filtering is recommended. If capacitance-input filtering is used, sufficient series impedance is required to keep the peak cathode current within rating.**

Relay Service. **With 60-cycle anode supply the grid regains control at the end of each positive half-cycle of the anode voltage, thereby providing on-off control. The grid can be excited from dc or from ac pulses up to 2 megacycles in frequency.**

Bias Service. **In low-voltage dc regulator circuits, a few ohms of resistance should be placed in series with any capacitance across the tube. Drop across the tube can be reduced about two volts by connecting the shield grid to the anode.**

Photo-Relay Service. **The tube will operate directly from a phototube. In this class of service, a grid resistance as high as 10 megohms may be used. The shield grid must be tied to the cathode.**

Relaxation Oscillator Service. **Shield the tube from rf fields and put rf impedances in series with the elements, otherwise the tube cannot deionize when the plate voltage drops below the sustaining potential.**

Inverter Service. **RCA-2050's can be used in inverter service at frequencies up to approximately 1000 cycles per second.**

Remote Control Service. **A number of remote circuits can be independently step-controlled over one pair of wires by using a 2050 at each remote circuit and having each 2050 arranged to operate at a different control-grid voltage.**

RCA-2050 THYRATRON — Gas-Tetrode

GENERAL DATA

Electrical:		
Heater for Unipotential Cathode		
Voltage*	6.3	ac or dc volts
Current	0.6	amp
Direct Interelectrode Capacitances (Approx.) :§		
Grid No. 1 to Anode	0.26	μμf
Input	4.2	μμf
Output	3.6	μμf
Tube Voltage Drop	8	volts
Control Ratio at Breakdown (Approx.)		
Grid No. 1 to Anode (Grid-No. 2 Voltage = 0)	250	
Grid No. 2 to Anode (Grid-No. 1 Voltage = 0)	800	

HAM TIPS is published by the RCA Tube Department, Harrison, N. J., and is made available to Amateurs and Radio Experimenters through RCA tube and parts distributors.

H. S. STAMM.....*Editor*
J. H. OWENS.....*Technical Editor*

Maximum Ratings, Absolute Values:		
Peak Forward Anode Voltage	180 max.	650 max. volts
Peak Inverse Anode Voltage	360 max.	1300 max. volts
Grid-No. 2 (Shield Grid) Voltage		
Before Conduction	—100 max.	—100 max. volts
During Conduction	—10 max.	—10 max. volts
Grid-No. 1 (Control Grid) Voltage		
Before Conduction	—250 max.	—250 max. volts
During Conduction	—10 max.	—10 max. volts
Peak Grid-No. 1-to-Anode Voltage (Grid negative with respect to anode)	—	750 max. volts
Peak Cathode Current	1.0 max.	1.0 max. amp.
Average Cathode Current†	200 max.	100 max. ma.
Surge Cathode Current for 0.1 sec. max.	10 max.	10 max. amp.
Peak Heater-Cathode Voltage:		
Heater negative with respect to cathode	100 max.	100 max. volts
Heater positive with respect to cathode	25 max.	25 max. volts
Ambient Temperature Range	—75 to +90	—75 to +90 °C

Typical Operating Conditions for Relay Service:		
RMS Anode Voltage*	400	volts
Grid-No. 2 Voltage	0	volts
RMS Grid-No. 1 Bias Voltage**	5	volts
Peak Grid-No. 1 Signal Voltage	5	volts
Anode Circuit Resistance‡	2000	ohms
Grid-No. 1 Circuit Resistance	1.0	megohm
Maximum Circuit Values:		
Grid-No. 1 Circuit Resistance:		
For Average anode current of 100 ma. max.	10	megohms
For Average anode current of 200 ma. max.	2	megohms

§Without external shield.

*Heater voltage must not deviate more than 10% from the rated value and must be applied at least 10 seconds before start of conduction.

†Averaged over any 30-second interval.

**Approximately 180° out of phase with the anode voltage.

‡Sufficient resistance, including the tube load, must be used under any conditions of operation to prevent exceeding the current ratings.

RCA Ham Tips

PUBLISHED - IN - THE - INTEREST - OF - RADIO - AMATEURS - AND - EXPERIMENTERS

VOLUME VII, No. 3 EDITORIAL OFFICES, RCA, HARRISON, N. J. JULY—SEPTEMBER 1947

807 DRIVES 8005 FINAL IN FLEXIBLE FOUR STAGE RIG

UNIT COVERS 80 TO 10 METER BANDS FOR PHONE AND CW WITH MEDIUM POWER

By George D. Hanchett, Jr., W2YM

The desire for a compact and flexible transmitter that would cover all the bands from 80 meters to 10 meters with an input of 300 watts for cw and 250 watts for phone prompted the design of the rig to be described. Many hours of thought resulted in plans for a unit using 80-meter crystals and having a minimum of four stages with an 8005 final driven by an 807. A fully electronic keying system, quick band-change, plug-in coils, meter switching for convenience and low cost, and symmetry of panel controls completed the goals we set up for our transmitter. Then we rolled up our sleeves and went to work.

The transmitter was built completely on a 17" x 13" x 3" cadmium plated chassis. Its panel size is 19" x 10½". The power supply, not illustrated, was built on another chassis of the same size.

The oscillator and multiplier plate-tuning condensers, as well as the meter switch, are mounted under the chassis with their control knobs brought out to the front panel. In order to keep the oscillator tank leads as short as possible, the oscillator tuning condenser is mounted slightly to one side; drive is accomplished through a flexible shaft.

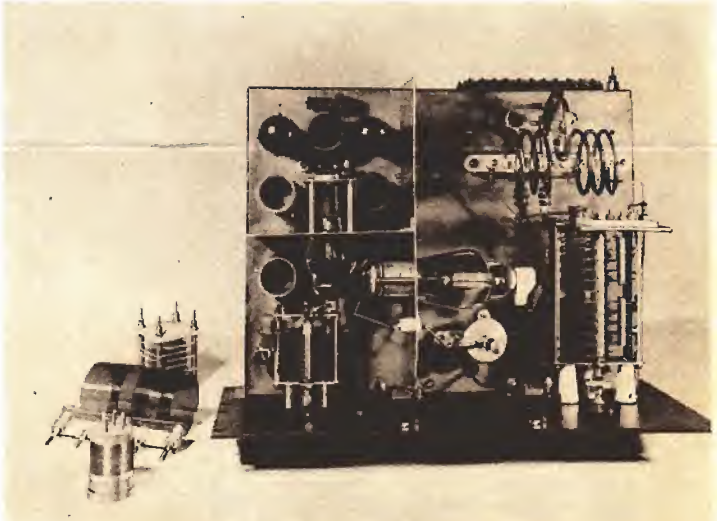
Both oscillator and multiplier tank condensers are mounted on polystyrene strips which are, in turn, affixed to metal supporting brackets. By means of this insulating method together with bakelite shafts, it is possible to isolate the condensers from ground, thereby allowing the dc voltage to be applied to the rotors. The arrangement eliminates the need for costly mica blocking capacitors capable of carrying tank currents.

Quick Band Changing

The band-change switch is a four-pole, three-position wafer type. The first pole of the switch in both the 20-meter and the 10-meter position applies plate voltage to the 6L6 multiplier. The second pole is used

(Continued on Page 2, Column 1)

BEHIND THE SCENES



A top view of the transmitter discloses a symmetrical layout to achieve maximum operating efficiency as well as an attractive appearance.

READY FOR A RAG-CHEW

This fine looking rig has an electronic keying system, quick band change, plug in coils, and meter switching—important in a unit designed for convenient operation and quality service.

AN ANALYSIS OF GRID DRIVING POWER AS LISTED IN TUBE OPERATING DATA

One important question that's sure to come up in the design of a new transmitter is how much power is needed to adequately drive the individual stages. Tube manufacturers have set up driving power figures in typical operating data, but unless this information is interpreted correctly, the driver stages may be under-designed.

The value of driving power shown in tube data bulletins includes only the actual power input to the grid plus the power lost in the bias supply. *It does NOT include rf losses that occur in the tube, tank circuit, socket and wiring, or losses in the tubes, caused by transit-time loading.*

It is not feasible for the tube manufacturers to give total driving power figures, because there is no way of anticipating conditions under which the tubes will be used. Grid power requirements will vary considerably, even in well-engineered designs, and the extreme ranges are quite large. It is better, therefore, that printed specifications indicate only the sum of grid power and bias losses.

Because the driver tube must supply all the losses between its plate and the grid of the driven tube, these losses must be added to the figure given in the tube data for driving power requirements. On an average, in the frequency range up to 30 Mc, the losses are large enough to dictate the choice of a driver tube which has a rated output of about twice the grid power rating of the driven tube.

Driving-power measurements are usually made at 100 kc—where rf losses in the tube are negligible—by measuring the peak rf grid voltage (Eg) and the average grid current (Iav). Then, the relation Wd = 0.9 Eg Iav, gives the driving power in watts. This is the figure shown in tube bulletins.

At higher frequencies consideration must be given to rf and transit-time loading losses. If the stage in question is to operate above 30 Mc, it is advisable to provide 3 to 10 times the published low-frequency driving power figure in order to insure sufficient drive plus a reasonable margin for safety.

After the design has been crystallized and the transmitter constructed, tests and adjustments should be made to insure that the

(Continued on Page 3, Column 4)

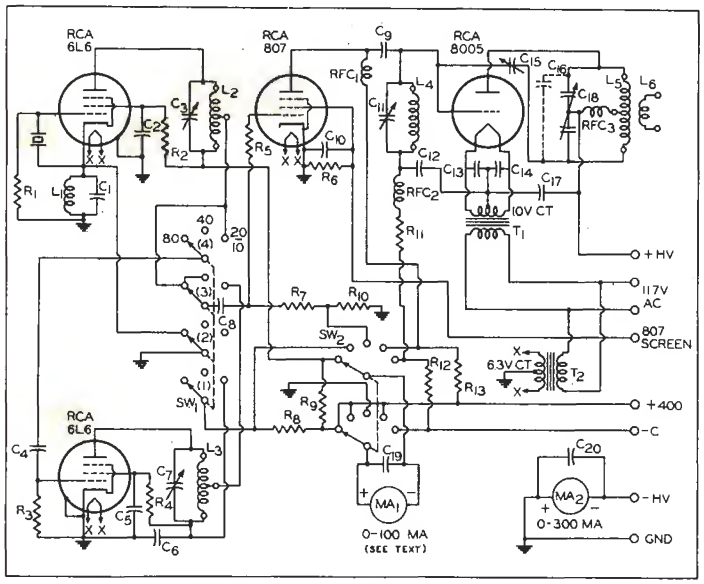


Figure 1. Transmitter schematic.

FOUR STAGE RIG

(Continued from Page 1, Column 4)

to short the cathode coil of the oscillator only when its plate circuit is tuned to the fundamental wave length of 80 meters. The third pole connects the grid of the 807 to the proper driving circuit. The fourth and last pole removes the excitation to the 6L6 multiplier when it is not in use.

One novel feature of this transmitter is that both the 807 buffer and the 8005 final are mounted horizontally. Better placement of parts can be accomplished when the tubes are placed in this position. The photographs show that the grid connection comes close to the grid tank and that the plate is near the plate tank. Those short connections are extremely helpful for 28-Mc operation.

When a filamentary tube such as the 8005 is mounted horizontally, care should be taken to see that the plane of the filament is vertical. Tubes other than the 8005 may be used in this manner except those employing helical filaments which are not recommended for borizontal mounting.

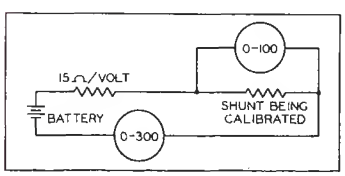


Figure 2. Schematic used in adjusting meter shunts.

Note that the 8005 has its socket mounted on the vertical shield partition. Shielding of the 807 is achieved with two aluminum shields. One shield runs perpendicular to the panel and a little to the left of center. The other is mounted parallel to the panel and slightly back of the chassis center. This arrangement adequately shields the 807 plate from its input circuit and also shields the 807 from the final tank circuit.

To eliminate the possibility of parasitic oscillations in the 807 buffer stage, connect a 50-ohm noninductive resistor in the grid circuit. This resistor should be placed as close as possible to the grid socket terminal.

On 3.5 to 4.0 megacycles, in order to obtain a desirable tank Q of 12, essential for reduction of unwanted harmonic output, it is necessary to add extra capacitance to the split-stator condenser. This is provided by the plug-in condenser, C 16. Two turns are removed from each end of the coil (L5) in order to obtain resonance with the larger total capacitance.

Metering Procedure

Metering of the 8005 plate circuit takes place in the negative return of the high-voltage supply. This method permits the meter to be mounted on the panel and not be a shock hazard. Metering the low-power stages as well as the grid of the 8005 is accomplished with a meter switch and a 100-ma instrument. The installation of new shunts permanently wired in for each position permits the meter to be switched to any of several circuits. This provides a very simple arrangement, *but one precaution must be taken. The meter switch must be of the non-shorting type.* Use switches such as Centralab #1405 or Mallory #1315L. For this transmitter the internal shunt was removed from the meter and five new shunts of equal resistance were constructed. Each was made from about 4 feet of #28 enameled wire, wound on a solder-lug terminal strip.

To adjust the new shunts, use a battery, a fixed resistor having about 15 ohms per battery volt, and the 300-ma meter (8005 plate), all in series with the 100-ma meter and shunt to be adjusted. This hookup is shown in Fig. 2. Wire should be removed from the home-built shunt until both meters read the same.

The meter positions of the switch are as follows:

1—oscillator plate current
2—multiplier plate current
3—807 grid current
4—807 plate current
5—8005 grid current

The two power supplies required for the transmitter are both mounted on a single 3" x 13" x 17" chassis. One is a low-voltage supply for the oscillator, multiplier, and buffer, and the second is a high-voltage supply for the 8005. Fig. 3 is a schematic diagram of the supplies. Bias voltage is obtained from a half-wave rectifier connected to the bias tap on the 400-volt power transformer. With no excitation to the 8005 final amplifier the grid bias should not be less than 70 nor more than 90 volts.

Electronic Keying

Keying of the transmitter is done electronically in the screen-grid circuit of the 807. This method was originated by W2RYI, and gives excellent clickless keying. In the key-up condition, the grid of the control tube, a 6L6 in this case, operates at zero bias resulting in a low internal tube resistance. This low resistance reduces the voltage at the anode of the voltage regulator tube (OC3/VR105) below that required for ionization. With no ionization, the VR tube is non-conductive and the result is an open circuit to the screen grid of the 807. Note in the circuit diagram that a 0.15-megohm resistor is connected between screen grid and ground to bleed off any charges collecting on the screen grid and to hold it at ground potential in the key-up position.

When the key is in the key-down position, cutoff voltage is applied to the control grid of the 6L6. This produces a very high internal resistance in the 6L6 so that adequate ionizing voltage appears at the anode of the VR tube. Now, the VR tube will ionize or fire, and complete the circuit between the screen grid and its supply voltage.

Capacitor C5 of the power supply is used to prevent key clicks. Increasing the size of the capacitor will increase the lag; reducing it decreases the lag. The novel features of this system are that only very small currents need be keyed and that the keying lag may be adjusted by changing the size of the capacitor.

Tuning Up the Rig

Tuning up the transmitter is quite simple. After the proper crystal and coils for the band desired are selected, the oscillator tuning condenser should be rotated to obtain the usual dip. The plate current of the oscillator will run about 20 to 25 ma on 80 meters and 25 to 30 ma on all other bands.

When the multiplier is to be used, tune it to resonance as quickly as possible because abnormally large currents flow when its plate circuit is out of adjustment. Normally, the plate current of the 6L6 will run about 30 ma on all bands.

Next, switch the meter to the 807 grid position and retune the multiplier or oscillator plate tuning condenser for maximum grid current. The 807 grid current should be between 4 and 5 ma on all bands. Switch the meter to the 807 plate circuit and hold the key down, then tune the 807 plate circuit for minimum current. The value should be in the neighborhood of 60 to 70 ma for all bands except 10 meters. On 10 meters the 807 plate current will run about 85 ma because in this position the 807 is operating as a doubler. When tuning the low power stages do not apply high voltage to the 8005.

When the driver stages have been tuned, the grid circuit of the 8005 should then be tuned. No high voltage should as yet be applied to the 8005. The meter switch is turned to the 8005 grid position and the

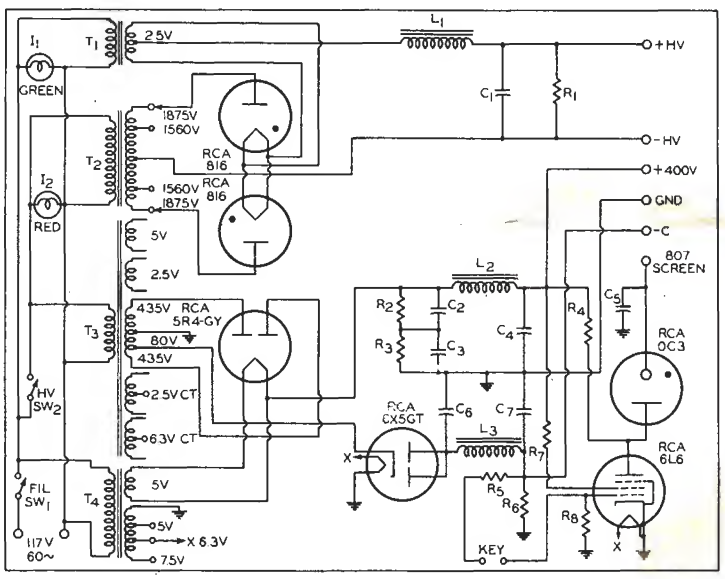


Figure 3. Schematics of power supplies.

Coil Data

Wavelength Band meters	L_2	L_3	L_4
80	A		B
40	C		D
20	C	E	F
10	C	E	G

80 meters Coil A — 30 turns # 22 wire, winding length 1⅜", tap at 12 turns.
Coil B — 27 turns #20 wire, winding length 1¼", no tap.

40 meters Coil C—17½ turns #20 wire, winding length 1¼", tap at 8 turns.
Coil D — 15 turns #18 wire, winding length 1¼", no tap.

20 meters Coil E — 10 turns #18 wire, winding length 1", tap at 5 turns.
Coil F — 6 turns #18 wire, winding length 1", no tap.

10 meters Coil G — 3 turns #14 wire, winding length 1¼", no tap.

All coils wound on National XR-5 forms or equivalent, 1½" diameter, 2¼" long.

807 plate tank adjusted to obtain maximum 8005 grid current. This grid current should run 30 to 35 ma on all bands but will be lower on the higher frequency bands. It is worth mentioning that the 807 does a good job of driving the 8005, even though it has a plate supply of only 400 volts and is capacitively coupled to the 8005 grid.

After the final amplifier has been neutralized as described below, the high voltage may be applied and the plate circuit tuned to resonance. Then, the pick-up loop can be connected to the antenna transmission line and the antenna coupling adjusted to load the tube to the desired plate current which, however, must not exceed 200 ma.

Neutralizing the 8005

Neutralization of the 8005 can be done as follows: with the high voltage off, tune the plate tank of the 8005 through resonance and observe the needle kick on the meter caused by a shift in grid current. Change the setting of the neutralizing condenser and check grid-current kick again. If the kick becomes less than before, the adjustment of the neutralizing condenser was in the correct direction. This procedure should be repeated until there is absolutely no kick noticeable on the grid meter. When the final has been neutralized, it will not require readjustment with change in operating frequency.

The 1875 volt power transformer T2 is tapped at 1560 volts. The full secondary will provide 1500 volts for the 8005 when it is used on CW. The 1560-volt ac tap will provide 1250 volts for the tube when it is plate modulated.

The builder of this transmitter should not experience any trouble in obtaining top performance. It is one of the most easily constructed and conveniently operated rigs that the author has used in his 18 years of Ham radio.

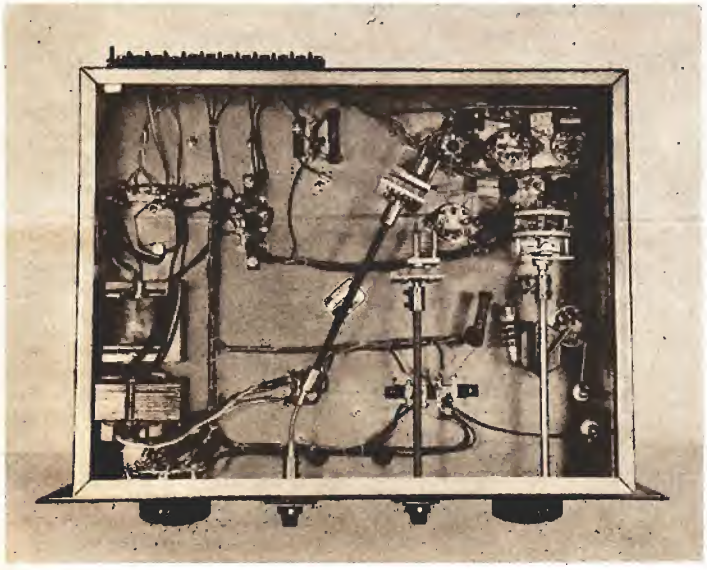
PARTS LIST—TRANSMITTER

C1	200 μμf, mica, 500 volts working
C2, C5, C6, C10	0.002 μμf, mica, 500 volts working
C3, C4	100 μμf, variable, 500 volts working
C7	50 μμf, variable
C8	500 μμf, mica, 500 volts working
C9	500 μμf, mica, 600 volts working
C11	65 μμf, mica, 0.070 spacing
C12	0.002 μμf, mica, 600 volts working
C13, C14	0.005 μμf, mica, 500 volts working
C15	National, NC 800 neut. condenser
C16	25 μμf, padding condenser, 0.25" spacing
C17	0.003 μμf, mica, 2500 volts working
C18	50 μμf per section, 0.171" spacing
C19, C20	0.002 μf, mica
R1	250,000 ohms, ½ watt
R2, R4	20,000 ohms, 1 watt
R3	100,000 ohms, 1 watt
R5	50 ohms (carbon) ½ watt
R6	150,000 ohms, 1 watt
R7	25,000 ohms, 1 watt
R8, R9, R10, R12, R13	Special meter shunt (#28 enameled wire on tie strip) see text
R11	3,000 ohms, 10 watts
RFC1, RFC2	National R-100
RFC3	National R-300
L1	10 turns of #20 wire wound 1" length on National form XR-5
L2, L3, L4	See coil data
L5, L6	B & W TVL coils
SW1	4 pole, 3-position Isolantite switch, non-shorting type
SW2	2 pole, 5-position switch
T1	10 volt, filament transformer
T2	6.3 volt, filament transformer

PARTS LIST — POWER SUPPLY

C1	4 μf, at 2000 volt, oil impregnated paper
C2, C3	8 μf, 450 volt, electrolytic
C4	20 μf, 450 volt, electrolytic
C5	0.05 to 0.25—adjust to suit keying requirements
C6, C7	20 μf, 150 volt, electrolytic
R1	50,000 ohms, 100 watts
R2, R3	0.5 megohm, 1 watt
R4	5,000 ohms, 25 watts
R5	10,000 ohms, ½ watt
R6	3,000 ohms, 10 watts
R7	50,000 ohms, 10 watts
R8	100,000 ohms, ½ watt
L1	12 h at 300 ma.
L2	13 h at 250 ma.
L3	8 h at 55 ma.
SW1, SW2	SPST toggle, 12 amp rating,
I_1, I_2	115 volt, 6-watt indicator panel lamp
T1	Thordarson T19F75 or equivalent, 2.5 volt at 5 amps.
T2	Thordarson T19P60 or equivalent, 1875-0-1875 and 1560-0-1560 at 300 ma.
T3	Thordarson T75R50 or equivalent, 435-0-435 at 250 ma., 80 volt bias tap
T4	Thordarson T19F76 or equivalent, 5 volt at 3 amps, 6.3 volt at 6 amps.

AN UNDER CHASSIS VIEW



Logical arrangement of components and wiring adds to the transmitter's operating stability.

NEW 816 VOLTAGE RATINGS

7500 volts is the new peak inverse voltage rating for the RCA-816. A pair of these tubes can now be used in a full-wave rectifier with a standard plate transformer having a 5000-volt center-tapped secondary. Such use is well within the new rating and with average quality components in a choke-input circuit will provide 250 ma. and a filter output voltage of about 2150 volts.

ECHOS

The "Torpedo Twin" article which appeared in the May-June issue of HAM TIPS listed R10 and R11 as 2-6000 ohm resistors in series. Actually the total resistance should have been 42,500 ohms minimum. A value of 45,000 ohms, or more, will be required in practice, and this can be obtained from a 20,000-ohm resistor in series with a 25,000-ohm resistor.

GRID DRIVING POWER

(Continued from Page 1, Column 2)

stages are being properly driven. If, as in many cases, an amplifier tube is to be operated with conditions differing somewhat from those published under a set of suggested typical operating conditions, the performance can be checked as follows. First, load the amplifier to the desired value of plate current. Then vary the grid current slowly (tank circuit tuning remaining unchanged) and note the change in output.

If the change in output is roughly proportional to the change in grid drive, the stage is underdriven. Then drive should be increased until very little increase in output results from a large increase in drive. Under this condition, the stage is said to be saturated. Of course, the maximum rated value of dc grid current should not be exceeded.

The penalties for an underdriven stage are low power output, low efficiency, and if the stage is plate modulated, severe distortion at high levels of modulation. The latter condition will readily be recognized as downward modulation, and if a pure sine wave is used for test, a decrease in average plate current will be noted as the modulation level is increased.

Correct Grid Drive Important

It is very desirable to saturate amplifiers, especially those driven by a series of frequency multipliers. This comes about because it is rarely possible to saturate frequency multipliers and stay within tube ratings. Consequently, a small decrease in supply voltage on the multiplier stages may cause a large decrease in grid drive and in output of the final amplifier stage. It is important, therefore, that the amplifier grid be saturated so that full output is maintained regardless of variations in supply voltages.

It is possible to overdrive as well as underdrive tubes. However, overdrive occurs rarely. There is little to be gained by over-driving and something to lose. Although there should be no actual damage to the grid or cathode unless the maximum ratings for dc grid current or dc grid bias are exceeded, overdriving can cause excess harmonic radiation and low power gain.

Over-driving a beam tube or pentode may cause the screen grid to be overloaded before the control grid. This condition may be checked by metering the screen current to determine whether the screen input is within ratings. Adjustment of both bias and screen voltage may be necessary to allow the tube to be properly saturated and still remain within screen input ratings.

The correct amount of grid drive is an important detail of power tube application. With other conditions properly maintained, it insures high power gain, high plate efficiency, and long tube life.

RCA-8005 TRANSMITTING TRIODE

FULL INPUT TO 60 MEGACYCLES. *Amateur Net* **$7.00**

Features

- Ceramic washer minimizes corona discharge—provides superior bond to glass and plate cap, eliminating strain.
- Nonex hard-glass envelope will not crack, buckle or puncture under high operating temperatures.
- Oversized 32.5 watt filament—the same as used in much larger tubes—has enormous reserve of emission.
- Drawn-tungsten seal rods have smoother surfaces—hence, provide superior seals against air leakage.
- Zirconium-coated molybdenum anode provides unusually rapid heat dissipation and permits greater power input.
- Sturdy metal base and low-loss ceramic insert combine strength with high heat and insulation resistance.
- A pair of 807's in Class B will plate modulate an 8005. A pair of 811's in Class B will handle two 8005's.
- The 8005 can be used within its ratings to replace any of the older types such as the 203A, 211, and 845. It is only necessary to install a new socket, install a flexible lead to the plate cap, and re-neutralize the circuit.

Application Considerations

- ***Power Gain.*** **Figure on a grid-to-plate power gain of 20 to 1 and you will have ample drive available. One 807 driver is okay. At 30 Mc, an 807 or 6L6 doubler with only 400 volts on its plate will do the job. An 807 buffer or doubler will drive a pair of 8005's.**
- ***Neutralization.*** **Adjust neutralizing condenser so that the grid-current peak and the plate-current dip occur at exactly the same point of plate tank tuning.**
- ***Circuit Q.*** **In single-ended service, the split-stator plate-tuning capacitance should be approximately 0.8 $\mu\mu$f per section, per meter.**
- ***Mounting.*** **The 8005 can be mounted horizontally as well as vertically.**

8005 TRANSMITTING TRIODE

GENERAL DATA

Electrical:

Filament, Thoriated Tungsten:	
Voltage	10 ac or dc volts
Current	3.25 amp
Amplification Factor	20
Direct Interelectrode Capacitances:	
Grid to Plate	5 $\mu\mu$f
Grid to Filament	6.4 $\mu\mu$f
Plate to Filament	1.0 $\mu\mu$f

Mechanical:

Mounting Position	Vertical, base down; or Horizontal, pins 1 and 4 in vertical plane
Overall Length	6-13/32" ± 5/32"
Seated Length	5-25/32" ± 5/32"
Maximum Diameter	2-7/16"
Bulb	ST-19
Cap	Medium, with insulating Collar
Base	Medium Metal-Shell Small 4-Pin, Bayonet

AF POWER AMPLIFIER AND MODULATOR—CLASS B

Maximum Ratings,
Absolute Values:

	CCS†	ICAS‡	
DC Plate Voltage	1250 max.	1500 max.	volts
Max.-Signal DC Plate Cur.*	200 max.	200 max.	ma.
Max.-Signal Plate Input*	225 max.	250 max.	watts
Plate Dissipation*	75 max.	85 max.	watts

Typical Operation:
Values are for 2 tubes

DC Plate Voltage	1250	1500	volts
DC Grid Voltage#	−55	−67.5	volts
Peak AF Grid-to-Grid Voltage	290	330	volts

HAM TIPS is published by the RCA Tube Department, Harrison, N. J., and is made available to Amateurs and Radio Experimenters through RCA tube and parts distributors.

H. S. STAMM ..... *Editor*
J. H. OWENS ..... *Technical Editor*

Zero-Signal DC Plate Current	40	40	ma.
Max.-Signal DC Plate Current	320	330	ma.
Effective Load Resistance (plate-to-plate)	8000	9800	ohms
Max.-Signal Driving Power (Approx.)	4	5.5	watts
Max.-Signal Power Output (Approx.)	250	330	watts

PLATE-MODULATED RF POWER AMPLIFIER—CLASS C TELEPHONY

Carrier conditions per tube for use with a max. modulation factor of 1.0

Maximum Ratings,
Absolute Values:

	CCS†	ICAS‡	
DC Plate Voltage	1000 max.	1250 max.	volts
DC Grid Voltage	−200 max.	−200 max.	volts
DC Plate Current	160 max.	200 max.	ma.
DC Grid Current	45 max.	45 max.	ma.
Plate Input	160 max.	240 max.	watts
Plate Dissipation	50 max.	75 max.	watts

Typical Operation:

DC Plate Voltage	1000	1250	volts
DC Grid Voltage§	−195	−195	volts
	7000	7000	ohms
Peak RF Grid Voltage	350	350	volts
DC Plate Current	160	190	ma.
DC Grid Current (Approx.)¶	28	28	ma.
Driving Power (Approx.)¶	9	9	watts
Power Output (Approx.)	115	170	watts

RF POWER AMPLIFIER AND OSCILLATOR—CLASS C TELEGRAPHY

Key-down conditions per tube without modulation•

Maximum Ratings,
Absolute Values:

	CCS†	ICAS‡	
DC Plate Voltage	1250 max.	1500 max.	volts
DC Grid Voltage	−200 max.	−200 max.	volts
DC Plate Current	200 max.	200 max.	ma.
DC Grid Current	45 max.	45 max.	ma.
Plate Input	240 max.	300 max.	watts
Plate Dissipation	75 max.	85 max.	watts

Typical Operation:

DC Plate Voltage	1250	1500	volts
DC Grid Voltage**	−115	−130	volts
	3800	4000	ohms
	520	560	ohms
Peak RF Grid Voltage	240	255	volts
DC Plate Current	190	200	ma.
DC Grid Current (Approx.)¶	30	32	ma.
Driving Power (Approx.)¶	6.5	7.5	watts
Power Output (Approx.)	170	220	watts

† Continuous Commercial Service.
‡ Intermittent Commercial and Amateur Service.
*Averaged over any audio-frequency cycle of sine-wave form.
For ac filament supply.
§ Obtained perferably from grid resistor of value shown, or combination of grid resistor with either fixed supply or suitably by-passed cathode resistor.
¶ Subject to wide variations depending on the impedance of the load circuit.
• Modulation essentially negative may be used, if the positive peak of the audio-frequency envelope does not exced 115% of the carrier conditions.
** Obtained from a fixed supply, by grid resistor (3800, 4000) or by cathode resistor (520, 560).

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RCA

Ham Tips

PUBLISHED - IN - THE - INTEREST - OF - RADIO - AMATEURS - AND - EXPERIMENTERS

VOLUME VII, No. 4 EDITORIAL OFFICES, RCA, HARRISON, N. J. OCTOBER—DECEMBER 1947

MODERN SPEECH AMPLIFIER USES 6AS7-G OUTPUT TUBE

KING OF THE KILOWATTS

More Versatile Than Ever!

Amateurs are advised that it is now practical to operate the RCA-833-A at a full kilowatt input in plate-modulated class C telephony service, without the use of forced-air cooling. Typical data for this new natural-air-cooled operation are yours for the asking. Write to Commercial Engineering, RCA, Harrison, N. J.

Amateur Net Just $45.00

EASILY BUILT ELECTRONIC BIAS SUPPLY GIVES REMARKABLE VOLTAGE REGULATION

By George D. Hanchett, Jr., W2YM

Zero-bias tubes don't need it, but many of the popular modulator tubes used by Amateurs do require some negative grid bias. The stringent requirement for good voltage regulation makes the problem quite difficult because it rules out the simple type of bleeder-filter circuit. As a result "B" batteries have been used extensively for class "B" modulator bias. However, a review of the literature revealed a better solution to the problem in a paper by George E. Pihl.*

The electronic bias supply described has better voltage regulation than dry batteries. It has greater flexibility, longer life, and is consequently less expensive. Of equal importance, it is a device which can be assembled easily in a few hours by the average Amateur.

Basically, it consists of a small power supply which delivers about 20 ma of current to an output triode. The voltage drop across the triode is used as the regulated bias voltage. Associated with the triode is a pentode dc amplifier and two glow-discharge "VR" tubes which serve to vary the grid voltage of the output triode so that a constant voltage is maintained across it. The voltage regulator tubes take about 20 ma as a "keep-alive current," so the rectifier and filter must supply a total current of about 40 ma.

The theory of operation can be explained by reference to the diagram in Fig. 2. Since the voltage drop across V_4 and V_5 is in parallel with the voltage drop across V_2 and R_5, any change in voltage across V_4 will appear in its entirety across R_5, because the voltage drops across both VR tubes remain fixed.

R_4 is the cathode bias resistor of V_3; therefore, any voltage change across it appears as a grid voltage change on V_3. This change in grid voltage is amplified by V_3 and appears across R_4 which is connected

(Continued on Page 3, Column 4)

*"A Voltage Stabilized Bias Supply for Power Tubes" by Geo. E. Pihl, Northeastern University Publication Bulletin #10—April 1943.

UNIQUE FEATURES OF TWIN TRIODE LEAD TO ITS CHOICE AS AUDIO TUBE

By J. H. Owens, W2FTW

Something old is something new in speech amplifiers. This latest design reverts to an old-fashioned triode output stage, and dispenses with modern inverse-feedback circuits. Such is the trend of progress!

But regardless of the old fashioned approach in design, *the output tube in this amplifier is really ultra-modern.* It's the 6AS7-G, a high-power twin-triode that was designed for use in regulated power supplies and television receivers. As an audio tube, it has two features which make it excellent for speech amplifier use:

Extra-low ac plate resistance. Only 560 obms, plate-to-plate, in a push-pull circuit.

Extra-high plate efficiency. Actually equal in efficiency to multi-grid tubes.

And what is wrong with multi-grid power tubes? Aren't they hum-free even with a mediocre filtered plate supply? Can't they be driven to full output with a very small grid signal? Aren't they exceptionally low in cost?

Yes. In fact, if they are fed into a constant resistance load, there is nothing particularly or peculiarly wrong with them. *Unfortunately for radio Amateurs, however, class B modulator grids do not present a constant impedance.* Instead, they are characterized by a constantly varying impedance, and one which varies sharply right during the cycle of an audio frequency signal.

To fully appreciate the importance of this unfavorable situation, consider its relation to one pertinent characteristic of multi-grid power tubes. If the load is removed from a pentode or beam tube power amplifier, the output voltage will rise about five or more times its fully loaded level. Imagine then, the distortion that is generated when one of the modulator grids traverses the threshold from positive to negative voltage.

(Continued on Page 2, Column 1)

STABILITY PLUS STYLE

This functional looking speech amplifier delivers 12 watts of actual power output to a load at less than 4% distortion.

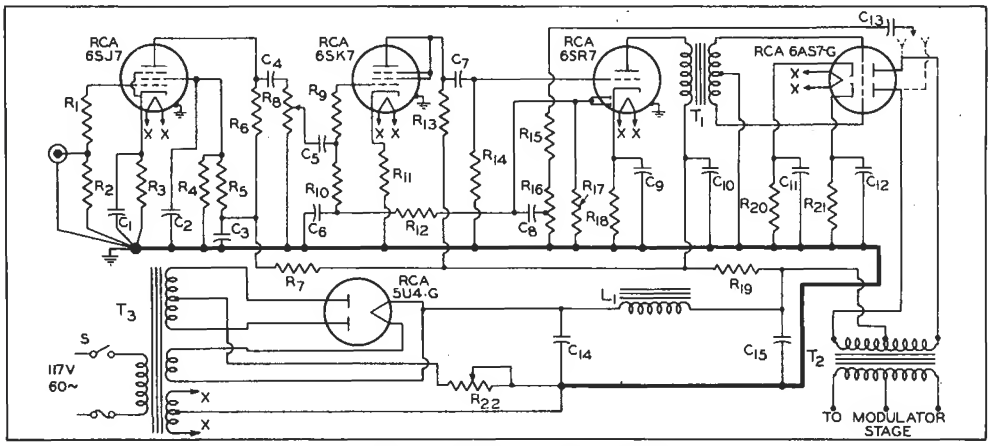


Fig. 1. Schematic of speech amplifier.

SPEECH AMPLIFIER

(Continued from Page 1, Column 4)

In terms of design practice, a speech amplifier must have good voltage regulation of the output signal. This can be achieved by use of tubes, such as the two sections of the 6AS7-G, having very low ac plate resistance. If multigrid tubes, with a plate resistance of about 100,000 ohms are used, it is necessary to use a great amount of feedback to obtain good regulation. This method is equally satisfactory, providing the feedback loop can be kept degenerative all the way from one cycle to a couple of hundred thousand cycles per second.

If the degenerative condition is not maintained, the amplifier is likely to motor-boat in the familiar "putt-putt" fashion, or voice its displeasure in a strident wail, or it may really cause confusion with random bursts of ultrasonic parasitic oscillations. Radio design engineers, working in manufacturers' laboratories, with the benefit of elaborate test equipment, are able to achieve such a control, but the average Ham shack is not so well equipped.

Pentode Difficulties

The use of a 6AS7-G eliminates pentode feedback difficulties, and at the same time gets around certain objections to filament-type triodes such as the 2A3, 6A3, and 6B4G. These tubes generate filament hum that can't be removed easily without the use of negative feedback. They also produce some distortion in a class AB circuit unless matched tubes are used or a bias correcting network is provided. Furthermore, they do not have the high plate efficiency of beam tubes or the 6AS7-G.

The 6AS7-G eliminates these objections. Filament hum is entirely removed by its heater-cathode construction. There are two triode units in a 6AS7-G and each one has its own cathode which comes out to a separate base pin. It becomes possible, therefore, to use separate cathode bias resistors and by-pass capacitors for each triode, permitting the two sections to be self-matching. Self-bias balancing of 2A3's would require two filament transformers, one for each tube.

Another important consideration is plate efficiency. For class A, or class AB_1 service, efficiency is simply related to the position or angle of the zero-bias line on the plate family of curves. Reduced to simple terms, high efficiency is obtained if a tube is able to draw high plate current at low plate voltage when the grid swings to zero. The efficiency is, in effect, a measure of the plate voltage swing that can be obtained with a given plate supply voltage and peak signal plate current.

Circuit Considerations

Reference to the plate family will show that a 6AS7-G plate will swing down to 30 volts when the plate current is 100 ma and the grid is at zero. This is identical to the performance of a 6L6 under equal conditions with a screen grid voltage of 250. By contrast, a 2A3 plate will swing down only to about 90 volts. When the 2A3 is operated with a plate-supply voltage of 300 volts, a half-cycle voltage of about 210 volts can be developed in the plate circuit with a 100 ma swing of plate current. A 6AS7-G will develop 220 volts with the same swing of plate current, but with a plate supply of only 250 volts.

An examination of the circuit design of the amplifier is appropriate at this point. As illustrated in Fig. 1, the schematic is quite conventional. A 6SJ7 was chosen for the input stage because of its high gain, *as well as its comparative stability in an rf field.*

The second stage tube is a 6SK7, triode connected. This type was chosen because it provides a variable-gain electrode for the injection of a dc compression or AMC voltage.

The third stage is a 6SR7, chosen because it has two diodes. If it were not for the AMC requirement, the type 6J5 would have been used in both the 6SK7 and 6SR7 stages. Plate, grid, and cathode resistors and capacitors would remain the same, but all components in the compression circuit would be omitted, and the 6SK7 series grid resistor would be connected to the movable arm of the volume control.

The 6SR7 is, of necessity, transformer-coupled to the 6AS7-G. Resistance-coupling will not supply the large grid swing that the 6AS7-G grids require. A transformer might be a disadvantage in an amplifier used for musical reproduction, but it has merit in a speech amplifier since it can be used to control the frequency response characteristic. With all-resistance-coupling, the amplifier response is flat, but the transformer changes the curve and gives it a rising high-frequency characteristic.

If a high-fidelity transformer were used, with parallel choke feed, the response would remain flat, or it could be tilted up at the low end. But when the transformer primary carries the 6SR7 dc plate current, its inductance is reduced. This decreases the impedance at the low-frequency end, reduces the response at that end, and, in effect, tilts up the high end.

Voice Phenomena

If a very small and cheap transformer is used, the effect is emphasized. With a two-pound transformer of intermediate quality, there is just enough high-frequency pre-emphasis to make speech crisp and highly intelligible.

High-frequency pre-emphasis plus bandwidth restriction has been practised by communication companies for many years. Suppression of fundamental voice frequencies below 400 cycles does not affect the intelligibility or the pitch of speech, but it does remove the sounds which would otherwise absorb 50% or more of the power-handling capabilities of the transmission medium.

To dwell a moment on voice phenomena, it is known that the deeper vowel formants range from approximately 400 to 900 cycles per second. The upper vowel formants go from 900 to about 2400 cps. Then the dominant sibilants occupy the band up to about four or five thousand cps. Within this range of 400 to 5000 cps. are the important sounds that help create and identify spoken words.

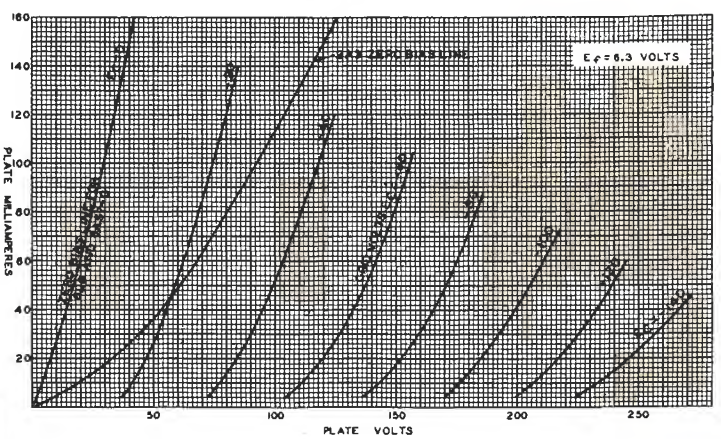
Other Considerations

The development of a story about the new 6AS7-G in a speech amplifier affords the opportunity to review other important design practices. Such things as rf feedback, suppression and hum reduction are too important to be overlooked.

To eliminate rf rectification and feedback, it is only necessary to prevent rf voltages from appearing between the grids and cathodes of the low-level tubes. Shielding is therefore very important, and metal tubes simplify the job. The metal shells are grounded to the chassis with leads as short as practicable.

Series grid resistors are more effective than chokes in keeping rf off of the grid terminals. Quarter-or half-watt carbon units should be used, and the ends going to the socket grid terminals should be clipped short. No other wiring should touch these grid socket terminals. The resistance values given in the parts list for these series grid resistors should be satisfactory for all circumstances, but they may be increased to 100,000 ohms each without ill effects.

Because the point most sensitive to rf feedback is the 6SJ7 grid, it should be examined first if feedback occurs. Incidentally, these grid resistors reduce the response to very high audio frequencies, thereby helping to narrow the channel and keep down the level of modulation splatter.



Average plate characteristics of the 6AS7-G for each triode unit.

Hum and Noise

The grounding system is the most important design factor to observe precisely in the construction of a high-gain amplifier. In fact, there are two grounds, a mechanical ground and an electrical ground. The mechanical ground is the chassis, metal component shields, inductor cores, and the metal tube shells. The electrical ground is the high-voltage dc return path to the center tap of the power transformer. The two grounds are separate, and are joined at only one single point near the input tube.

The electrical ground bus goes from the filter, to the power stage, to the 6SR7, to the 6SK7, to the 6SJ7, and finally to the point of contact with the mechanical ground. All electrical returns are made to it in progression as shown. This is important because it prevents the low-level stages "seeing" minute voltage drops produced by the flow of currents from higher-level stages.

The 6SJ7 returns are the most critical. In order to get high gain with lowest hum, it is necessary to bring the ac and dc grid and cathode returns to a common point. The microphone cable shield also grounds at this point rather than at the chassis where the microphone jack is located. The jack must be insulated from the chassis. From this final terminal point in the electrical ground system, a short wire goes to a convenient point on the chassis ground near the 6SJ7 socket.

The 6SJ7 is also the most critical tube for microphonics. To keep such noises at a minimum, the tube is cushion mounted on rubber grommets. On the same cushioned socket mounting plate are solder-lug terminal strips on which all of the associated resistors and capacitors are mounted. Connections from these to other parts of the circuit are made through flexible "test lead" wires.

The Filter

One disadvantage of low-mu output triodes is that they require a well filtered plate supply. The filter choke must be employed as shown because a large portion of any power supply ripple will be transmitted by the tubes through the output transformer to the modulator grids.

One precaution to observe in designing the filter is to make sure that the main capacitor pack does not use the container can as the negative terminal. If it does, the can will have to be insulated from the chassis to preserve separate electrical and mechanical grounds.

There is little need for good power supply regulation in this amplifier because the power tubes are operated in class A. Even at full signal, the total plate current rises only a few milliamperes; large voltage fluctuations are not therefore encountered.

The AMC Circuit

Provision for volume compression was incorporated in the amplifier because it can be quite beneficial when used with discretion. If the compression control is set so that the 6SR7 diodes begin to rectify at about 80% to 90% modulation, and if the volume control is advanced about 3 db higher than its normal position, the AMC circuit will help prevent overmodulation. If the time-delay circuit is not too slow, it may also increase the loudness of carelessly "swallowed" words, thereby improving to a certain extent the average intelligibility of transmitted signals.

A word of caution. Too much compression is readily possible. If the gain control is advanced more than 6 db and if the compression control is set so that rectification starts below the level of 75% modulation, an effect of blooping, burping, and gasping speech will be created. Words will start explosively and end faintly. Furthermore, overmodulation will occur.

There is one special precaution to be taken in the compressor wiring. For best results, it is essential that a voltage of proper phase be delivered to the 6SR7 diodes, otherwise the gainshift "bloops" will be over-emphasized.

To get the right connection, disconnect bypass capacitor C6 and try the plate coupling capacitor C13 on first one and then the other 6AS7-G plate. One connection will cause some hum and a tendency to motor boat or howl. The other connection, the right one, may cause the amplifier to oscillate at some high frequency, but will tend to suppress any hum or low-frequency noises. It does this because it provides some inverse feedback at very low frequencies. With the time-constant capacitor C6 back in the circuit, the effect of the feedback is small, but beneficial.

The amplifier is so stable that the mechanical design layout is unimportant. As shown, this unit is built on a 12" x 3" x 7" chassis. On top of the chassis are the power transformer, interstage transformer, main capacitor pack, output transformer, and the tubes. The filter choke and other components are mounted underneath in convenient locations.

This new amplifier will deliver twelve watts of actual power output to a load at less than 4% distortion. This is adequate to drive any of the class B modulator tubes used in conjunction with a one-kilowatt final amplifier, with plenty of power to spare.

The electronic bias supply shown above provides a regulated bias voltage adjustable from 30 to 80 volts and handles a rectified grid current up to 200 ma.

PARTS LIST

R1	47000 ohms, ½ watt
R2	2 Meg., ½ watt
R3	1000 ohms, ½ watt
R4	120000 ohms, 1 watt
R5	680000 ohms, 1 watt
R6	220000 ohms, 1 watt
R7	33000 ohms, 2 watts
R8	500000 ohms, grid-taper pot
R9	47000 ohms, ½ watt
R10	390000 ohms, ½ watt
R11	2200 ohms, ½ watt
R12	560000 ohms, ½ watt
R13	150000 ohms, 1 watt
R14	270000 ohms, ½ watt
R15	82000 ohms, 1 watt
R16	50000 ohms, pot, wire-wound
R17	560000 ohms, ½ watt
R18	1200 ohms, ½ watt
R19	10000 ohms, 4 watts, wire-wound
R20	2500 ohms, 10 watts, wire-wound
R21	2500 ohms, 10 watts, wire-wound
R22	200 ohms, 10 watts, wire-wound
C1, C9	10 μf, 25 volts
C2	0.1 μf, 400 volts
C3	0.25 μf, 400 volts
C4,5,7,8	0.05 μf, 600 volts
C6	0.1 μf, 200 volts
C10	8 μf, 450 volts
C11,12	12 μf, 150 volts
C13	0.1 μf, 600 volts
C14,15	20 μf, 450 volts
T1	Thordarson T-20A22 or Stancor A-83-C
T2	Stancor A-4761, A4762, or equivalent
T3	Halldorson 74-S, or equivalent
L1	10 h at 125 ma

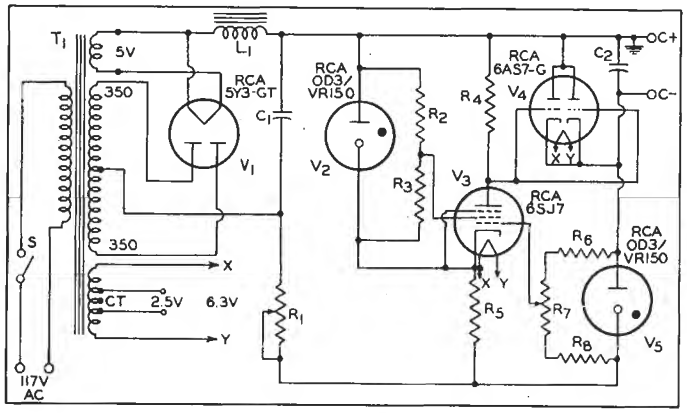


Fig. 2. Schematic of electronic bias supply.

ELECTRONIC BIAS SUPPLY

(Continued from Page 1, Column 2)

directly to the plate of V_3 and the grids of the output tube V_4. This change in voltage swings the grid of V_4 more positive or negative and thus varies the internal resistance of tube V_4, maintaining the drop across it practically constant.

The unit shown in the schematic diagram will provide a regulated bias voltage adjustable from 30 to 80 volts, and will handle a rectified grid current up to approximately 200 ma. The unit can be adjusted down to 20 volts but at this voltage only about 100 ma can be handled. This voltage range covers the grid-bias requirements of nearly all the tubes used by Amateurs as class B modulators.

For those amateurs who are interested in the performance of the regulator the calculated voltage regulation is 0.001 volts/ma. This means that when the supply is set to, say, 45 volts a grid current of 200 ma through it will cause the bias voltage to rise to 45.2 volts. This change is so very small that it is not perceptible on the meter.

PARTS LIST

R1	5000 ohms, 25 watts, wire wound
R2	24000 ohms, ½ watt
R3	68000 ohms, ½ watt
R4	270000 ohms, ½ watt
R5	3000 ohms, 5 watts, wire wound
R6	120000 ohms, ½ watt
R7	100000 ohms, potentiometer
R8	27000 ohms, ½ watt
C1	20 μf, 450 volts
C2	20 μf, 150 volts
L1	8 h at 50 ma (ac/dc replacement choke)
T1	Thordarson T-13R20 or UTC R-11; 350-0-350 at 50 ma; 5 volts at 2 amps; 6.3 volts at 3 amps
S	Single pole, single throw toggle switch

RCA-6AS7-G LOW MU TWIN POWER TRIODE

Amateur Net ~~$5.45~~

Reduced To **$4.25**

Features

- High Efficiency. Usable plate swing is almost equal to plate voltage.
- Good Stability. Low amplification factor insures freedom from regeneration.
- Two Cathodes. Allows use of self-bias balancing of the two triode units.
- Low Distortion. Even harmonics almost cancel in class A push-pull circuits.
- Excellent Voltage Regulation. Output signal varies but slightly with change in load.
- Twin-Unit Construction. Provides circuit layout convenience.
- In voltage regulator service, a load current of 250 ma can be controlled with one 6AS7-G. Because of the 300-volt heater-to-cathode rating, no separate filament winding is needed.
- In bias regulator service, the tube's low internal resistance allows regulation as low as 20 volts.

Application Considerations

The following recommended practices should be observed when the 6AS7-G is used in audio-frequency amplifier applications.

1. The two units should always be used in push-pull, never parallel.
2. Always use self bias; fixed bias must not be used.
3. Separate cathode bias resistors, and by-pass capacitors, should be used for each unit.
4. The total series grid resistance, per unit, should be limited to one megohm.
5. Transformer, or impedance-coupling devices should be used in order to get sufficient voltage to fully swing the grids.
6. The transformer-coupled driver tube should be a medium-mu triode such as the 6J5, 6SR7, 6C4, 6SN7, 12AU7, etc. For self-biased operation of the driver tube, by-pass its cathode resistor with a capacitance of 8 uf or more.
7. The plate supply voltage for the driver tube should be at least 250 volts in order to obtain sufficient grid swing for the 6AS7-G.
8. In a voice-frequency speech amplifier using a single driver tube, the plate of the driver tube can be series-fed through the primary winding of the interstage push-pull transformer.
9. In wide-band, flat-response, audio amplifier service, the grids can be excited by:
   (a) a push-pull stage through a high-fidelity push-pull interstage transformer.
   (b) a push-pull stage through a center-tapped plate choke, capacitance-coupled to resistor-fed grids.
   (c) a single tube with choke-fed plate, through a capacitance-coupled single-plate-to-push-pull-grids high-fidelity transformer.

6AS7-G LOW-MU TWIN POWER TRIODE

GENERAL DATA

Electrical:	
Heater, for Unipotential Cathode:*	
Voltage	6.3 ac or dc volts
Current	2.5 amp.
Mechanical:	
Mounting Position	any
Maximum Overall Length	5-5/16"
Maximum Seated Length	4-3/4"
Maximum Diameter	2-1/16"
Bulb	ST-16
Base	Medium Shell Octal 8-Pin

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J. H. OWENS, W2FTW ..... *Editor*
H. S. STAMM, W2WCT ..... *Associate Editor*

AUDIO AMPLIFIER SERVICE

Values are for each unit

Maximum Ratings, Design Center Values:			
PLATE VOLTAGE	250 max.		volts
PLATE CURRENT	125 max.		ma
PLATE DISSIPATION	13 max.		watts
PEAK HEATER-CATHODE VOLTAGE			
Heater negative with respect to cathode	300 max.		volts
Heater positive with respect to cathode	300 max.		volts
Typical operation, Class A_1 push-pull amplifier. Unless otherwise specified, values are for both units.			
Plate	200	250	volts
Grid	-90	-125	volts
Cathode Resistor (per unit)	1500	2500	ohms
Peak AF grid to grid voltage	190	255	volts
Zero signal plate current	120	100	ma
Max. signal plate current	128	106	ma
Effective load resistance (plate to plate)	4000	6000	ohms
Total harmonic distortion (less than)	4	4	per cent
Max. signal power output	11	13	watts
Amplification Factor (per unit)	2.0	2.0	
Plate Resistance (per unit)	280	280	ohms

* It is essential that precaution be taken in equipment design to prevent subjecting the tube to full load current of 250 ma before its cathodes have reached normal operating temperature. The cathodes require approximately 15 seconds to attain normal operating temperature. Unless this precaution is observed, the cathodes will be seriously damaged, if not completely ruined. In speech amplifier service, as indicated under typical operating conditions, the plate voltage may be applied simultaneously with the filament voltage.

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